

CALIFORNIA'S CONTAMINATED GROUNDWATER

Is the State Minding the Store?

Written by

Alex N. Helperin

David S. Beckman

Dvora Inwood

Contributors

Valerie Ledwith

Wendy Blankenburg

Project Director

David S. Beckman

NATURAL RESOURCES DEFENSE COUNCIL
April 2001

ACKNOWLEDGMENTS

This report was prepared by NRDC's Urban Program in our Los Angeles office. NRDC wishes to thank Environment Now and the Sidney Stern Memorial Trust for their generous support, as well as our members—more than 400,000 nationwide—without whom our efforts to protect natural resources would not be possible. We are especially grateful to our Los Angeles members and supporters. The authors would like to acknowledge the important contributions made by our colleagues Hal Candee, Barry Nelson, Erik Olson, and Gina Solomon.

The authors would also like to thank the many scientists, advocates, and professionals who shared their experiences and expertise with us, especially, Tyler Dillavou, Carl Hauge (Chief Hydrogeologist with the Division of Water Resources), Julia Huff (U.S. Geological Survey, Water Resources Division), Elizabeth Janes (U.S. EPA Groundwater Office), Anthony Meeks (Department of Health Services), Rick Rhoda (Department of Health Services, Drinking Water and Environmental Division), Nancy Richard (State Water Resources Control Board), David Storm (Department of Health Services), Anthony Saracino (hydrogeologist), Saracino-Kirby, Inc., Terry Tamminem (Executive Director, Environment Now), and Marguerite Young (Clean Water Action). In addition, we are grateful for the insightful peer reviews provided by Brendan Dooher (Lawrence Livermore National Laboratories), Professor Harrison Dunning (School of Law, University of CA, Davis), Terry Flemming (U.S. EPA, Region IX), James Goodrich (water resources and environmental consultant), and Kevin Graves (Senior Water Resource Control Engineer, State Water Resources Control Board). Of course, specialists in this area have reached different conclusions about the most effective approach to groundwater management and their kind participation here should not be taken as an endorsement of our approach.

ABOUT NRDC

The Natural Resources Defense Council (NRDC) is a national nonprofit environmental organization dedicated to protecting the world's natural resources and ensuring a safe and healthy environment for all people. With more than 400,000 members and a staff of lawyers, scientists, and other environmental specialists, NRDC combines the power of law, the power of science, and the power of people in defense of the environment. NRDC, which has offices in New York City, Washington, DC, San Francisco, and Los Angeles, has been actively involved in protecting our water resources for many years.

Copy Editor

Dana Foley

Production Supervisor

Emily Cousins

NRDC President

John Adams

Production

Bonnie Greenfield

NRDC Director of Communications

Alan Metrick

NRDC Executive Director

Frances Beinecke

ISBN 1-893340-27-9

Copyright ©2001 by the Natural Resources Defense Council, Inc.

For additional copies of this report, please send \$7.50, plus \$1.50 shipping and handling, to: NRDC Publications Department, 40 West 20th Street, New York, NY 10011. California residents must add 7.25% sales tax. Please make checks payable to NRDC in U.S. dollars only.

To view this report online, or to obtain more information online about NRDC's work, visit our site on the World Wide Web at www.nrdc.org.

This report is printed on paper with 100% postconsumer content, processed chlorine-free.

CONTENTS

Executive Summary	v
Chapter 1	1
An Introduction to Groundwater	
Chapter 2	7
The Big Picture: Statewide Information on California's Groundwater Basins	
Chapter 3	27
Down and Dirty: California's Contaminated Aquifers	
Chapter 4	65
A Patchwork Picture: Groundwater Assessment in California	
Chapter 5	73
Improving Groundwater Assessment in California	
Glossary	85
Endnotes	87
Figures	
Figure 1: How Groundwater Occurs	1
Figure 2: Groundwater Extraction	2
Figure 3: Types of Wells	3
Figure 4: The Hydrologic Cycle	5
Figure 5: Drinking Water Sources That Exceed MCL	17
Figure 6: Drinking Water Sources and Superfund Sites	21
Figure 7: State and Federal Cleanup Sites	22
Figure 8: State Cleanup Sites by County	23
Figure 9: Total Federal and State Cleanup Sites by County	24
Figure 10: Groundwater Impacts at DTSC Cleanup Sites	25
Figure 11: Salinity in California Groundwater	30
Figure 12: Salinity in Ventura County Groundwater	31
Figure 13: Salinity in Kern County Groundwater	32
Figure 14: Organic Compound Detections in Drinking Water Sources	36

Figure 15: Leaking Underground Fuel Tank Sites in California	38
Figure 16: MTBE: The Dirty Dozen	40
Figure 17: Nitrogen in California Groundwater	43
Figure 18: Nitrogen in San Bernardino Groundwater	44
Figure 19: Counties with Significant Pesticide Detections	46
Figure 20: The Pesticide DCBP in Drinking Water Sources	48
Figure 21: Average Arsenic Concentrations in Groundwater by County (1990–2000)	51
Figure 22: Chromium Levels in Drinking Water Sources	53
Figure 23: LUFT Sites and Public Wells	56
Figure 24: LUFT Sites Located Within One-Half Mile of Public Drinking Water Wells	57
Figure 25: Radon in Drinking Water Sources	60
Figure 26: Wells Taken Out of Service 1984–2000	71

Tables

Table 1: Groundwater Monitoring Agencies	8
Table 2: Major Findings of the 305(b) Report (2000)	13
Table 3: Top Six Causes and Sources of Contamination: A Decade of 305(b) Report Groundwater Data	14
Table 4: Contaminants Detected Above Maximum Contaminant Levels	18
Table 5: Organic Chemicals Detected in California Groundwater in the mid-1980s	34
Table 6: Reported MTBE Detections in Drinking Water Sources (as of January 3, 2001)	41
Table 7: Leaking Tank Sites by County	58
Table 8: Types of Protection Afforded by Various Federal and State Laws	74

EXECUTIVE SUMMARY

Beneath the surface of the earth lies a vast body of water. It does not exist in a large underground lake or a flowing underground stream but rather as tiny droplets of water, interspersed among the grains of soil and rock that we commonly picture when imagining the world underground. Nevertheless, the aggregate volume of those tiny water droplets is greater than the volume of all the lakes and rivers of the world combined. In fact, the volume of groundwater is estimated to be more than 30 times the combined volume of all fresh-water lakes in the world and more than 3,000 times the combined volume of all the world's streams.¹ In California alone, current supplies of usable groundwater are estimated at about 250 million acre-feet²—six times the volume of all of the state's surface water reservoirs combined.³

For more than 100 years, groundwater has provided a substantial and essential resource for California's agriculture, its industries, and its cities. It was not long after statehood in 1850 that California's residents began building pumps to extract this plentiful resource from the subsurface. The scarcity and seasonal availability of surface water, especially in the southern half of the state, have caused Californians to turn time and time again to the state's groundwater supply.

Indisputably, the availability—and, more importantly, the deficiency—of all forms of freshwater have substantially influenced California's history and development. In fact, water is widely considered the single most significant natural resource affecting the growth of the state.⁴ Given the arid climate that pervades most of the southern half of the state⁵ and the limited supply of running water, legendary political and economic battles occurred over access to the waters of the Mono Basin, the San Joaquin River, the Owens Valley, the Colorado River, and the Sacramento-San Joaquin Bay Delta.⁶

Yet despite their importance, these surface water bodies are only part of the water picture in California. Between 25 and 40 percent of California's water supply in an average year comes not from surface streams or reservoirs but rather from beneath the ground. That figure can be as high as two thirds in critically dry years.⁷ In fact, California uses more groundwater than does any other state.⁸ Californians extract an average of 14.5 billion gallons of groundwater every day—nearly twice as much as Texas, the second-ranked state.⁹

Fifty percent of California's population—some 16 million people—depends on groundwater for its drinking water supplies.¹⁰ But of course, groundwater is used for much more than just drinking water. California also leads the nation in the number of agricultural irrigation wells, with more than 71,000.¹¹ In the Lower Sacramento River Valley alone, approximately 750,000 acres of prime agricultural land are irrigated, at least in part, by groundwater.¹² Indeed, many areas of the state rely *exclusively* on groundwater for their water supplies.¹³ In the lower Sacramento Valley, for example, approximately one million people rely on groundwater to supply all of their water needs.¹⁴

For all of these reasons, the California Department of Water Resources has concluded that water from California's groundwater basins "has been the most important single resource contributing to the present development of the state's economy."¹⁵



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

Yet despite the importance of this resource, until relatively recently groundwater never received a degree of attention or protection commensurate with its value to society. Part of that failure may be due to ignorance. Until recently, groundwater was believed to be both naturally pristine and immune from contamination by surface activities.

We now understand that the quality of the water stored underground in aquifers (the geological formations that hold groundwater) is fragile. Groundwater resources can be effectively diminished if they become contaminated to such a degree that the water remaining in the aquifers is rendered unusable—or requires expensive treatment in order to be made usable. Technological advances continue to make treatment a more viable option and may eventually permit the use of once-abandoned groundwater reserves, as we learn to remove more types of contaminants and at lower costs. However, at least for the foreseeable future, true groundwater remediation is generally a time-consuming and costly process.

Yet without remediation, most forms of contamination will persist and may even worsen. Unlike an aquifer suffering from depletion, which may rebound naturally during the next wet season without human intervention, a contaminated aquifer may remain contaminated (depending on the nature of the contaminants) for hundreds, or even thousands, of years. Furthermore, contaminants will inevitably spread—albeit very slowly—within any given groundwater basin. Finally, some lag time inevitably exists between the contamination of water and the discovery of that contamination, often with some further delay before the use of the contaminated water is terminated. Thus, contamination not only results in a reduction in the amount of immediately usable water, but may also result in human exposure to hazardous levels of contaminants.

For these reasons, the contamination of our groundwater resources is a serious, long-term threat to the viability of the resource in California, a state that relies on its groundwater for many purposes. Understanding the full extent of the problem, and generating reliable information on trends that can inform policy and resource allocation decisions, are the best, and indeed, most basic, approaches to safeguarding this natural resource. Surprisingly, the information that is available about the quality of groundwater in California, as well as water quality trends, is extremely limited—and often unreliable. Perhaps not so surprisingly, existing information, including some of the most reliable data available, paints a picture of widespread groundwater contamination in California.

WHAT DO EXISTING STATEWIDE DATA TELL US?

The primary state assessment mechanism for determining the condition of the state's groundwater resources is a report produced by the State Water Resources Control Board, and updated every two years, known as the "305(b) Report."¹⁶ The most recent edition suggests that more than one third of the areal extent of groundwater in the state (a two-dimensional measurement of the surface area of the land under which groundwater basins are located) is contaminated to such a degree that it

cannot safely be used for all of the purposes the state has designated as appropriate and desirable. According to the year 2000 update of the 305(b) Report, each of the five most prevalent and harmful classes of contaminants *independently* contributes to the impairment of more than 15 percent of the groundwater assessed in the state, as measured by surface area.¹⁷ Furthermore, the causes of this contamination are many and varied. Several major sources and activities continue to contribute to groundwater pollution, including septic systems, landfills, leaking underground storage tanks, and agricultural operations.

While existing data paint a picture of a significantly degraded natural resource, the incomplete and often fundamentally unreliable nature of this information is an equally significant problem. NRDC's investigation revealed that the 305(b) Report, for example, although ostensibly the most comprehensive and thorough analysis of the state's groundwater basins, is so seriously flawed that its groundwater data is of questionable value. The problems in the 305(b) Report's groundwater information range from data-collection inaccuracies to a lack of substantiation for basic assumptions.¹⁸ Indeed, within a few days after NRDC provided the State Water Resources Control Board, the agency responsible for the 305(b) Report, with an advance copy of this NRDC study, the Board announced that even it did not consider much of its own groundwater data to be reliable.¹⁹ Although the Board has been publishing the same or similar data for nearly ten years without caveat, on March 22, 2001 senior Board staff wrote to NRDC and the federal Environmental Protection Agency and declared that the "State Water Resources Control Board (SWRCB) staff is retracting all groundwater assessment information from the SWRCB's year 2000 Clean Water Act (CWA) Section 305(b) report." This unprecedented action by the primary state agency charged with water quality control is indicative of the challenge facing California in attempting to understand the full extent of statewide groundwater contamination.

There are other agencies involved in collecting information about the quality of California's groundwater resources, but that is as much a part of the problem as a solution. Multiple agencies manage often competing monitoring and assessment systems, none of which is adequate on its own as a means of effectively assessing and protecting groundwater quality throughout California. Notwithstanding the good intentions of many state agencies, a failure to reform a highly fragmented and inefficient monitoring and assessment approach leaves California unprepared to assess and protect adequately this critical natural resource in the twenty-first century.

FINDINGS AND RECOMMENDATIONS

In order to characterize the condition of California's groundwater resources and the effectiveness of the groundwater monitoring and assessment system employed by responsible state agencies, NRDC searched for and reviewed available data on the condition of the resource and the sources of the most prevalent contaminants found within it; we also assessed the means by which this information is gathered. The data upon which NRDC relied came primarily from a variety of government

agencies, at both the state and federal level. NRDC used that data, other information, and its own professional judgment, to derive a list of five significant and representative groundwater contaminants and their sources. We then analyzed each one in greater detail, based on the most comprehensive and reliable data available with respect to those specific contaminants and sources. Based on that research, NRDC found that:

Available information suggests significant contamination of California's groundwater basins. Specifically:

- ▶ According to questionable State Water Resources Control Board data, more than one third of the areal extent of groundwater assessed in California is so polluted that it cannot fully support at least one of its intended uses, and at least 40 percent is either impaired by pollution or threatened with impairment;
- ▶ Groundwater contaminants include both naturally occurring substances, such as some metals, and anthropogenic ones, such as pesticides. Salinity, organic compounds, pesticides, nutrients, and metals are among the most significant types of contaminants that threaten or impair groundwater basins in California;
- ▶ Large numbers of drinking water wells regularly exceed drinking water standards (with thousands of exceedances last year alone), necessitating various means of treatment prior to the delivery of water to users;
- ▶ Groundwater contaminants have been detected at levels that exceed applicable federal or state standards throughout many regions of California. Likewise, a variety of contaminants, reflecting a range of human activities and natural causes, threaten or impair groundwater basins in California.

There are several significant sources of that contamination:

- ▶ Leaking underground storage tanks, natural sources, agriculture, land disposal, seepage, and industrial point sources are leading causes of groundwater contamination.

There is no comprehensive groundwater monitoring program in California—and available information is often of dubious quality. Specifically:

- ▶ The status of California's groundwater resources is monitored by an array of different agencies (both state and federal) with little, if any, coordination among them;
- ▶ The format in which the information about groundwater quality is presented can be deceptive, in that agencies assess the quality of the water relative to certain standards (which may or may not be appropriate), rather than relative to its natural state or to previous measurements, thus obscuring the degree to which the water's composition has been altered and providing no data trends;
- ▶ Much of the general data, such as information generated by the State Water Resources Control Board about the scope of the state's groundwater impairment problem, is simply incomplete and/or unreliable, making it difficult to know for sure the condition of one of California's most important natural resources;
- ▶ Agencies that do collect reliable data, such as the Department of Health Services, the Department of Pesticide Regulation, and the U.S. Geological Survey, do not

survey the groundwater basins throughout the state in a comprehensive manner from which conclusions might be drawn regarding the status of the resource as a whole.

Based on the findings of this study, NRDC concludes that there are a number of reforms and improvements that need to be made at the state level in order for California to improve its stewardship of the quality and usability of its groundwater resources.

In particular, NRDC makes the following recommendations:

- ▶ The state agencies responsible for protecting and managing California's groundwater resources (particularly the State Water Resources Control Board, the Department of Health Services, and the Department of Water Resources) should improve the scope and quality of their information by instituting a more systematic and ongoing monitoring program and by standardizing the formatting of the data gathered;
- ▶ A single agency should be responsible for compiling all of the information and for making that information readily accessible to the general public;
- ▶ The significant inadequacies and errors contained in the 305(b) Report should be remedied through a complete reformation of this critical statewide groundwater assessment;
- ▶ The agency or agencies responsible for protecting California's groundwater resources and the health of California's residents should develop a better understanding of the actual contaminants that are affecting the groundwater and the sources from which they come;
- ▶ The Legislature should ensure that adequate funding is provided to support these programs;
- ▶ The Legislature should ensure adequate implementation and enforcement of prevention programs to prevent further contamination of groundwater resources;
- ▶ The agency or agencies responsible for remediation of contamination within groundwater basins should ensure timely remediation of already contaminated sites;
- ▶ The Legislature should institute "polluter pays" provisions for groundwater contamination to compensate the individuals or agencies conducting remedial activities. However, it should clearly provide that remediation is not to be contingent upon identification of the responsible parties and that collection of compensation is not to be a prerequisite to remedial action.

AN INTRODUCTION TO GROUNDWATER

CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

Groundwater is, as its name suggests, water that is located beneath the surface of the ground. In fact, despite the earth's appearance as a solid mass of soil and rock, so much of the earth's subsurface is filled with water that, at any given time, groundwater is the largest single source of freshwater available for human use—domestic use, drinking water, agriculture, and industrial uses.¹

Hydrogeologists divide the subsurface into two categories—the unsaturated (or “vadose”) zone and the saturated zone² (see Figure 1). The vadose zone is filled with air, water, and other gases, but the water adheres to the surfaces of the sediment grains and cannot be easily extracted.³

Farther down, in the saturated zone, lies true “groundwater.” Contrary to popular myth, groundwater does not occur in underground rivers and lakes but is stored in the millions of tiny spaces within permeable soil and rock formations called “aquifers.”⁴ These aquifers can be divided into two types based on their composition: either porous sediments or fractured hard rock.⁵ The vast majority

FIGURE 1
How Groundwater Occurs

Source: Groundwater, U.S. Geological Survey General Interest Publication, Reston, Virginia, 1999 revision.

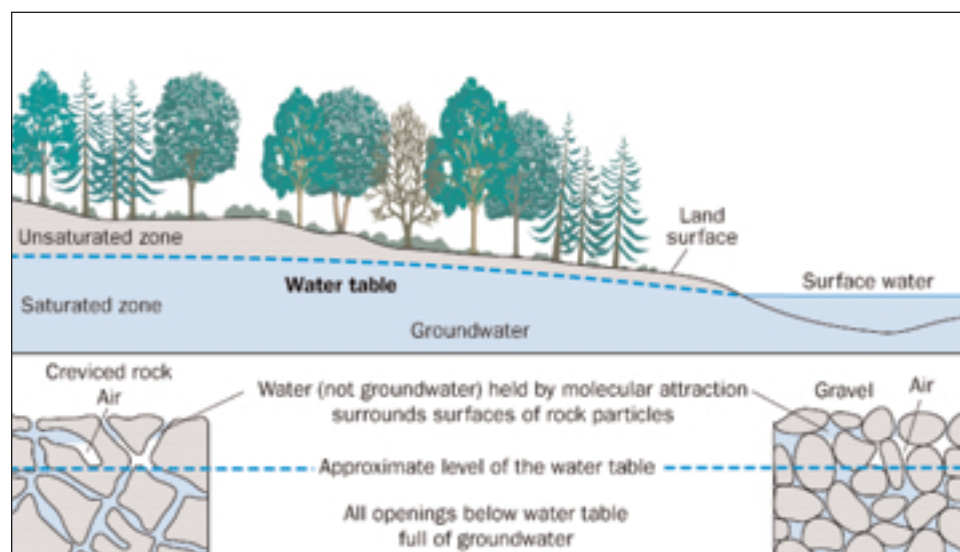
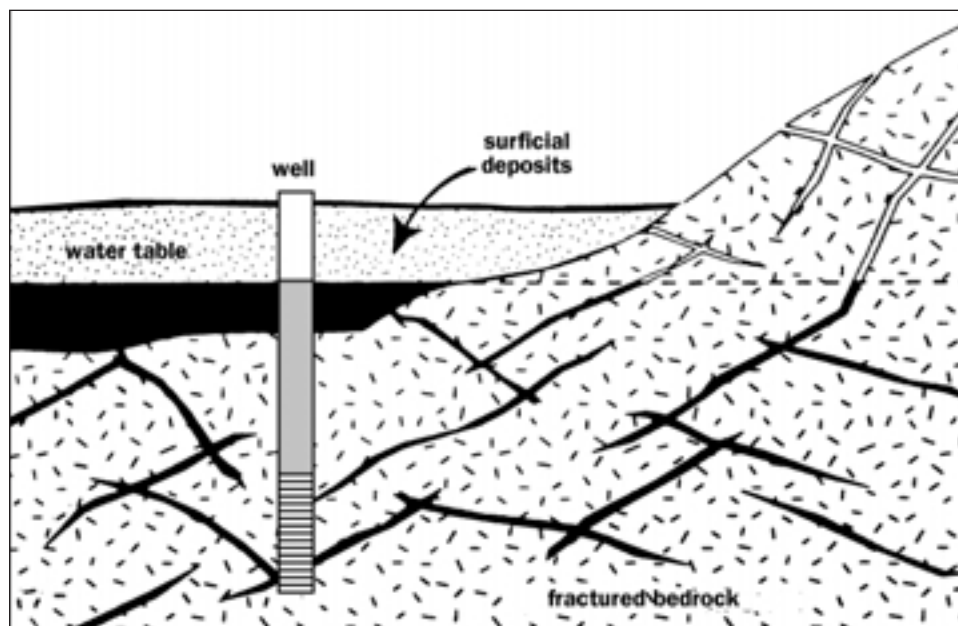


FIGURE 2**Groundwater Extraction**

Wells naturally fill to the level of the water table. This well receives groundwater from both the porous surficial deposits and the fractured bedrock (hardrock). The fractures in hardrock are in reality no more than 1-millimeter wide. They are exaggerated here for illustrative purposes. Storage capacity of hardrock is much less than the storage capacity of the surficial deposits.

Source: USEPA, Seminar Publication: Wellhead Protection: A Guide for Small Communities, (1993) EPA/625/R-93/002.]



of California's developed aquifers are of the first type and are composed of unconsolidated sand and gravel.⁶ The groundwater resides in the spaces (known as "pore spaces") between the grains of these sediments.⁷ Major aquifers of this sort exist in the Central Valley, San Francisco Bay area, the Salinas River Valley, many Southern California areas, and parts of the desert.⁸ The second type of aquifer, fractured hard rock, occurs in mountainous areas around the state and often beneath the unconsolidated sand and gravel aquifers.

The saturated zone is so named because groundwater fills in *all* of the spaces (or pores) in the aquifers. In a simple, "unconfined" aquifer, the top of the saturated zone is known as the "water table" (see Figure 1). If a well is drilled down into the saturated zone, water from the sediments surrounding the well will seep into the empty space created by the drilling of the well until the well fills with water approximately to the level of the water table. If that water is then pumped out of the well, more water will move from the pore spaces in the aquifer into the well, replacing the water that was removed.⁹ In this manner, groundwater can be pumped to the surface for human use (see Figure 2).

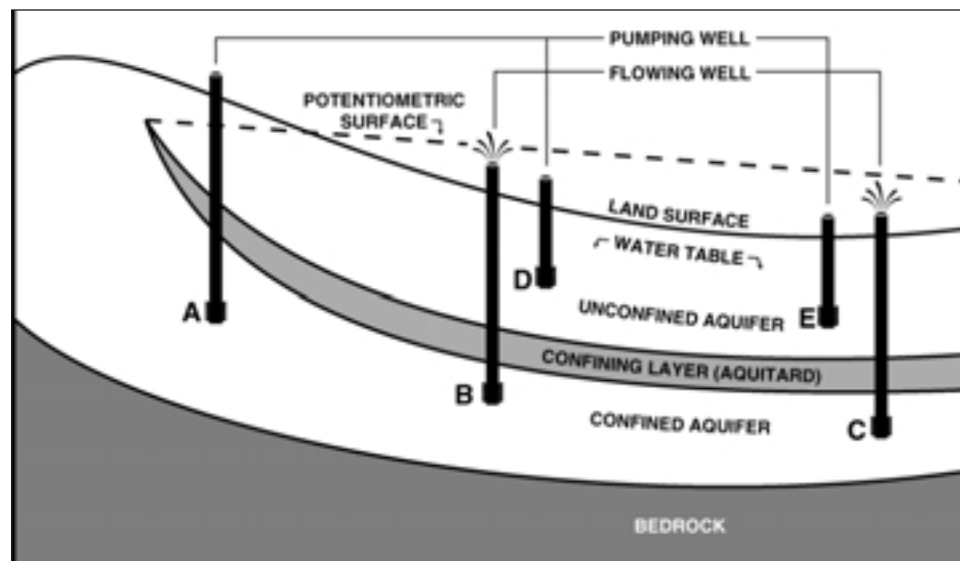
Not all aquifers are so simple, though. California's aquifers frequently contain layers of clay and silt mixed in with the sand and gravel. Although these clay and silt layers are also saturated with water, the spaces between the grains of these materials are too small to allow water to pass through easily.¹⁰ These deposits

FIGURE 3

Types of Wells

Wells A, B, and C are artesian because they perforate the confined aquifer. Groundwater rises to the level of the potentiometric surface, resulting in flowing wells in the cases of wells B and C. For well A, however, the potentiometric surface is below the ground surface, and water does not flow from the wellhead. Wells D and E do not reach the confined aquifer, and water levels reflect the level of the water table.

Source: Department of Water Resources, "Water Facts, Number 6," Ground Water (June 1993), p. 3



therefore impede the movement of the groundwater, forming local confining units in the aquifers, known as "aquitards."¹¹ The groundwater beneath an aquitard is pressurized, and the aquifer is referred to as "confined" or "artesian."¹² If the artesian pressure in these aquifers is high enough, when wells penetrate the confining layers, the groundwater will rise to the surface of the ground and flow freely out of the well head¹³ (see Figure 3).

THE INTERCONNECTION BETWEEN SURFACE WATER AND GROUNDWATER

Aquifers provide a theoretically sustainable source of water because the removal of water from an aquifer is not a one-way street. Groundwater is replenished by surface water that percolates down through the ground's surface.²² This process is referred to as groundwater "recharge."²³ Groundwater also escapes from other parts of the aquifer back to the ground's surface, through a process known as "discharge." A spring is a good example of natural discharge. Under natural conditions, groundwater basins are in a state of dynamic equilibrium, with the amount of water entering through recharge areas equaling the amount that is discharged.²⁴ However, human activity can result in "artificial" recharge and discharge as well, thus altering that balance.

The movement of water through the subsurface is governed by the same forces that govern surface water, but groundwater moves much more slowly. Under most circumstances, groundwater moves less than 1,000 feet per year.²⁵

HISTORY OF GROUNDWATER PUMPING

Ever since ancient times, people have dug wells in order to access groundwater. Stories throughout the Bible (both Old and New Testaments) refer to wells,¹⁴ and the City of Jerusalem could not have maintained its population without underground water systems and wells.¹⁵

In California, while individual residents may have relied on wells long before statehood, it was not until the latter half of the 19th century that use of groundwater became noteworthy. Due to the artesian pressure that existed in many of California's coastal aquifers, farmers in the coastal basins were able to dig flowing artesian wells, in which the groundwater would fill to the ground surface and pour out of the earth. This abundant water supply allowed agriculture to grow swiftly in these fertile valleys. As early as 1850, California farmers produced enough wheat to support the entire state, thus ending any wheat imports. This agricultural boom truly developed on the backs of groundwater wells. "By 1865, there were close to 500 wells in the [Santa Clara] Valley as settlers switched from dryland farming to irrigated agriculture."¹⁶ In the 1870s, when the demands of irrigated agriculture began to exceed surface water supplies, similar groundwater development began in the Los Angeles area. By 1880, such developments had occurred in the Antelope Valley and the Central Valley as well.

As groundwater extraction increased, the natural pressure in the aquifers diminished. By 1891, most of the wells in the Antelope Valley had stopped flowing. Soon after 1900, the situation was the same in the Central Valley.¹⁷ In Southern California, artesian wells still numbered 2,500 in 1900, but by 1930, only 22 were left.¹⁸ It became necessary to actively extract the groundwater collecting in the lower levels of the wells. Pumps were installed in the Central Valley at the beginning of the 20th century and in the Antelope Valley by 1915.¹⁹

Groundwater pumping increased dramatically in the San Joaquin Valley, and the number of wells increased almost 20-fold from 1906 (600) to 1920 (11,000).²⁰ The invention of the deep-well turbine pump around 1930 allowed for withdrawals from even greater depths and encouraged further development of groundwater resources for irrigation.²¹

Recharge and Discharge

The water that recharges groundwater basins begins as precipitation, in the form of rainfall and snow melt. Because precipitation is greater at higher elevations and because most of California's groundwater basins are in relatively arid valleys, most natural recharge comes from streams flowing into and/or across valleys.²⁶

However, only a fraction of the precipitation that falls makes its way into groundwater basins. Some of the water evaporates before it can enter the subsurface, and some flows to surface water bodies, such as lakes or the ocean. Even the portion that does enter the subsurface can still evaporate from the unsaturated zone or be taken up by plants and transpired.²⁷ Finally, some water is held in the unsaturated zone by molecular attraction to the soil and will not reach the aquifer. Thus, only the "excess" water, which is not taken up by the soil, plants, or evaporation, makes its way through the vadose zone to the water table.²⁸ The precipitation that falls

directly onto the valley floors in most of the southern half of California never gets that far down.²⁹

Human activity provides additional recharge mechanisms. Crop irrigation, for example, can lead to groundwater recharge, as it generally involves the application of more water than the crops can use, applied at a pace too fast for the excess to evaporate.³⁰ Humans have also employed methods of intentional "artificial" recharge, such as spreading water over recessed areas of land to allow it to infiltrate, or injecting it directly into an aquifer.³¹ Both of these methods can use local water that is diverted from its course or imported water that is brought in specifically for these purposes. In addition to these methods, the phrase "in lieu recharge" is often used to refer to the use of surface water for irrigation in lieu of groundwater, as that substitution accelerates recharge and suspends extractions.³²

Discharges also occur both naturally and by "artificial" means. Natural discharges occur continuously.³³ Water escapes from a basin at a low point, where it enters the ocean, a lake, or a stream, or where it emerges in a seep or spring.³⁴ Pump wells, on the other hand, are a form of artificial discharge.

The Hydrologic Cycle

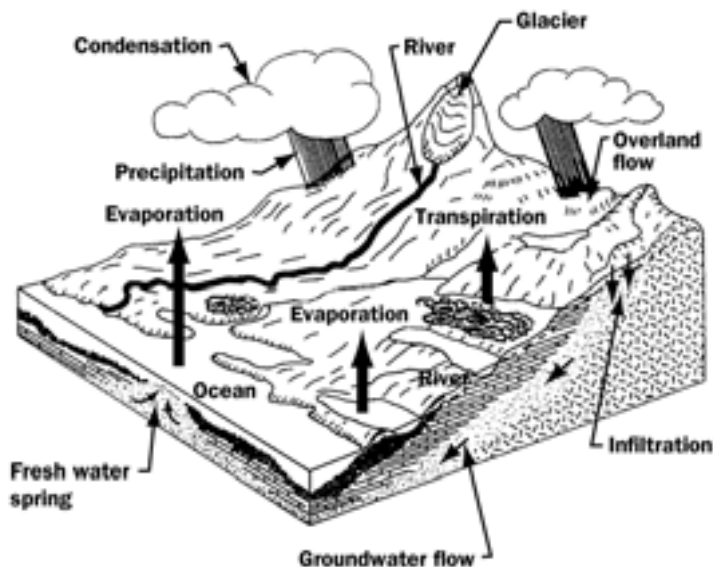
The process of recharge and discharge as well as the evaporation and precipitation of water above the water table form a complete "hydrologic cycle" (see Figure 4). It is clear from this cycle that groundwater and surface water are not two separate resources but rather a single, integrated resource, continuously being exchanged between the atmosphere, the ground surface, and the subsurface.³⁵ Due to the

FIGURE 4

The Hydrologic Cycle

Water naturally moves between the atmosphere, the ground surface, and the subsurface, by the processes indicated.

Source: Department of Water Resources, "Water Facts, Number 6," Ground Water, (June 1993), p. 1.



interconnection among these various bodies of water, a change in one realm will frequently affect the others.³⁶ This fundamental principle has been recognized in legal proceedings and is memorialized in a 1991 ruling in a federal lawsuit, entitled *NRDC v. Duvall*.³⁷ It is impossible to understand, protect, or efficiently manage our groundwater resources without understanding the complete hydrologic system and the dynamics that affect it.³⁸

THE BIG PICTURE: STATEWIDE INFORMATION ON CALIFORNIA'S GROUNDWATER BASINS



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

The research conducted by NRDC revealed a number of interesting facts. First and perhaps most significantly, it revealed that there is no easy access to comprehensive and reliable data on the status of California's groundwater resources. The data that do exist are compiled and maintained by an array of state and federal government agencies. Due in part to their differing charges, each of these agencies maintains data reflecting a different aspect of groundwater quality. The data are often also in different formats, making them difficult to compile. Finally, some of the most ostensibly comprehensive data proved to be the least reliable.

Second, to the extent that NRDC was able to obtain (or generate) summary data about the status of California's groundwater resources, those data revealed an apparent abundance of contamination, some naturally occurring and some anthropogenic. Five groups of contaminants studied in detail by NRDC—salinity, organic compounds, nitrates, pesticides, and metals—are notable causes of impairment (or threatened impairment) in many places in California. Third, seven sources of contaminants—agriculture, industry, landfills, leaking underground storage tanks, natural sources, resource extraction, and septic systems—represent a range of known contributors of contaminants that can threaten and impair groundwater. These five contaminants and seven sources are discussed in greater detail in Chapter 3.

We begin by explaining the universe of agencies from which the data were acquired and by providing an overview of the implications of those data.

WHO ASSESSES THE GROUNDWATER?

California's surface water monitoring and public information program has been improving steadily over the last several years. For example, Assembly Bill 411 (the Right-To-Know Bill) created a regular monitoring program from April to October at all major beaches and imposed requirements for conspicuous warning signs whenever the beachwater fails to meet state water quality standards. Similarly,

Assembly Bill 982, signed by Governor Davis in 1999, requires the State Water Resources Control Board to assess its surface water monitoring program in a report to the Legislature and propose improvements to remedy flaws in that system.

California's groundwater, however, does not receive any systematic, statewide attention or monitoring. Several government agencies compile incomplete reports on groundwater basins and potential groundwater contaminants. Each agency approaches the subject from a distinct perspective, based on its individual mandate, and no single agency provides a comprehensive, reliable, qualitative analysis of the resource as a whole. Furthermore, it is difficult, if not impossible, to combine the various sources of data because each agency collects different information and organizes and encodes its information in a different fashion. While nearly a dozen state and federal agencies have at least an indirect relationship to groundwater regulation, few focus on it directly. Table 1 summarizes the major agencies involved in groundwater quality management and their respective focuses, as discussed in more detail below. It also identifies some of the limitations of each agency's data—inadequacies significant enough to be of concern not only to specialists in the field but to state policy-makers as well. These problems and limitations are discussed fully in Chapter 4.

TABLE 1
Groundwater Monitoring Agencies

Agency	Focus of study	Approximate time period of agency data	Limitations
U.S. Geological Survey	Individual studies and randomly acquired data.	Since 1900	Only systematic with respect to individual, geographically limited studies.
U.S. Environmental Protection Agency (EPA)	Specific contaminated sites proposed for federal oversight of cleanup and funding from the Superfund. ^a	Since 1980	Limited to sites over which EPA may have jurisdiction under CERCLA, limited data on groundwater.
	Data received from the states under the 305(b) Report program. ^b	Since 1975	No systematic monitoring and only sporadic data.
California State Water Resources Control Board; Regional Water Quality Control Boards	Groundwater quality as a whole—condition of the resource.	Since 1975	No systematic monitoring and only sporadic data.
California Department of Health Services	Drinking Water sources and potential threats thereto, under the Safe Drinking Water Act. ^c	Since 1984	Only monitors active sources of drinking water; only highlights results above the state drinking water standard.
California Department of Pesticide Regulation	Pesticide use and presence in the environment.	Since 1988	Only tests for certain legal pesticides and their active ingredients.
California Department of Toxic Substances Control (DTSC)	Specific contaminated sites proposed for State oversight of cleanup process and funding.	Since 1982	Limited to sites over which DTSC may have jurisdiction; limited data on groundwater.
All of the above			Only look at specific constituents.

^a The "Superfund" Program is under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601-9675.

^b The "305(b) Report" program is mandated by section 305(b) of the Federal Water Pollution Control Act (the Clean Water Act). 33 U.S.C. § 1315(b).

^c The California Safe Drinking Water Act is codified at Cal. Health & Safety Code, Div. 104, Part 12, Chap. 4, §§ 116275-750. The federal Safe Drinking Water Act is codified at 42 U.S.C. §§ 300f-300j-11.

Federal Agencies

U.S. Geological Survey: At the federal level, the U.S. Geological Survey (USGS) began a project in 1991 to assess the status and trends of water quality in selected aquifers (and surface water bodies) across the country. The "National Water-Quality Assessment Program" includes three major studies in California: in the Santa Ana Basin, the Central Valley's San Joaquin-Tulare Basins, and the Sacramento River Basin.¹ The USGS has reached some broad conclusions on the basis of this program: for example, in the Santa Ana Basin, the agency found that the groundwater quality in the basin becomes progressively poorer as water moves along hydraulic flow-paths,² suggesting the presence of contaminating activities all along that route. The USGS also maintains an extensive database of all the sample results it receives, whether from its own studies or elsewhere. That database contains information on approximately 70,000 sites across California.³

Environmental Protection Agency: The U.S. Environmental Protection Agency (EPA) maintains multiple databases of contaminated parcels of land. These sites are generally brought to EPA's attention in conjunction with a request for federal funding to help clean up the contamination.⁴ EPA's main database, known as the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), identifies almost 800 sites in California, including about 100 that have already been approved for funding under the Superfund program and placed on the National Priorities List.⁵ CERCLIS does not provide any simple means of determining the types of contaminants at the various sites, but it does present an overview of contamination sites. This database is described further on Page 20.

State Agencies

California Department of Health Services: At the state level, the Department of Health Services' (DHS) Drinking Water Program, within the Department's Division of Drinking Water & Environmental Management, maintains a database of water quality test results from all Public Water Systems (see Glossary), as required by California's Safe Drinking Water Act.⁶ According to DHS, approximately 1,920 such systems, covering up to 16,000 active drinking water sources, currently report their test results to the Department on a regular basis.⁷ The Drinking Water Program has no authority over private wells, however, which total almost one million.⁸ It also does not collect information on wells that have been removed from the drinking water system. Analyses of current information collected by the department under the California Safe Drinking Water Act are presented in greater detail beginning on Page 16.⁹

The Department's Drinking Water Program also runs the state's "Drinking Water Source Assessment and Protection" program, which is mandated by the federal "Source Water Assessment Program."¹⁰ The state program involves three essential steps: (1) identifying the areas around drinking water sources through which contaminants might reach the drinking water supply; (2) inventorying ongoing activities that could lead to the release of contaminants within the

California's groundwater, however, does not receive any systematic, state-wide attention or monitoring.

delineated areas, known as “possible contaminating activities,” or “PCAs”; and (3) for each drinking water source, determining “the PCAs to which the . . . source is most vulnerable.”¹¹

Department of Pesticide Regulation and Department of Toxic Substances Control:

Other statewide agencies that provide limited monitoring of groundwater basins include the Department of Pesticide Regulation (DPR) and the Department of Toxic Substances Control (DTSC). DTSC runs a “site remediation program” and maintains a database of sites where hazardous materials have been released to the subsurface, similar to the federal CERCLIS database. DPR maintains a fairly comprehensive database of pesticide¹² use and performs tests to assess the level of pesticides in surface water and groundwater. These surveys only cover the presence of certain *legal* pesticides in California’s groundwater¹³ and are reviewed in the following chapter, in the section on pesticides.

State Water Resources Control Board: The State Water Resources Control Board (State Water Board), more than any other single agency, has been designated as the agency responsible for collecting systematic data on the condition of California’s water resources—both surface and ground. Every two years, the State Water Board compiles information on the quality of the state’s various bodies of water in an update to a report known as the “305(b) Report,” named after section 305(b) of the federal Clean Water Act, which mandates its production.¹⁴ The information for the report comes to the State Water Board from its nine regional subdivisions (the Regional Water Boards).

There are significant concerns regarding the comprehensiveness and the accuracy of the recent updates to the 305(b) Report, as discussed further in this chapter and in Chapter 4. These concerns are magnified in light of the fact that the 305(b) Report is the only regular assessment designed to compile statewide information about the condition of California’s groundwater resources as a whole.

Department of Water Resources: Another state agency with responsibilities related to groundwater is the Department of Water Resources (DWR). The California Legislature made DWR its own agency in 1956 (it had been a Division of the Department of Public Works) and empowered it to manage the state’s water supply. With a staff of 2,700 and a \$1 billion annual budget, DWR focuses mostly on surface water issues such as flood control, dam safety, the Sacramento-San Joaquin River Delta restoration, the state’s water budget, and operating the Nation’s largest water distribution system, known as the “State Water Project.”¹⁵ However, the agency also provides some technical, administrative, and financial support to local agencies for the monitoring, mapping, replenishment, and use of both surface and groundwater.¹⁶ DWR also maps the state’s groundwater basins and is responsible for well reports that are filed when a well is drilled. However, the agency has no statutory authority to protect groundwater quality, and its role with respect to such issues as monitoring and protection is quite limited.¹⁷

WHAT COUNTS AS CONTAMINATION?

Water occurs in nature in vastly different levels of purity,¹⁸ with innumerable different constituents potentially suspended or dissolved within it. Water is also used for many different purposes, and, depending on the uses demanded of it, certain constituents may be present in water to varying degrees without diminishing the water's usefulness for those purposes. Some specific constituents are even beneficial for certain uses.

However, many constituents—including many found in California's groundwater basins—can severely limit the uses that can be made of water. These constituents may occur naturally, or they may be the result of human activities (anthropogenic). Human activities have changed the concentrations of constituents in many water bodies and have added new constituents not found in nature, often resulting in new limitations on the uses of the water and/or exacerbating existing limitations. It is the presence of contaminants¹⁹ at levels that restrict the uses of water (or that threaten to do so) that is the focus of this report. Accordingly, this report uses the word “contamination” to refer to the presence of impurities in water at a level exceeding an official standard that was developed to protect public health or to safeguard some other use(s) of the water. (We do not limit our definition to anthropogenic sources of contamination because groundwater basins can and should be managed to protect human health against even naturally occurring forms of contamination.)

This report does not make subjective assessments as to when contamination is present. Rather, we rely on formal determinations to assess when the concentration of contaminants is severe enough to limit the uses of water. These determinations include those made in official documents issued by the State Water Resources Control Board (305(b) Report) and the Department of Toxic Substances Control (official cleanup site lists), as well as formal state and federal health standards such as those issued by the Department of Health Services, the Office of Environmental Health Hazard Assessment, and the U.S. Environmental Protection Agency.

As to the specific uses that are the focus of this report, unquestionably human life cannot be sustained without water to drink and food to eat, and, in fact, the vast majority of California's groundwater use is either for drinking water or agriculture.²⁰ Thus, this report, like the State Water Board, recognizes that direct consumption and food production are the most critical uses of groundwater for humans.²¹ When water is contaminated to the point of being unusable for these purposes, absent often costly treatment, it results in the loss of an essential resource. Accordingly, agencies such as the ones listed above have developed specific numerical water quality standards (maximum constituent-concentration levels) to protect these uses of the water.

GLOBAL INFORMATION ON THE STATE OF THE RESOURCE

“All of [California's] groundwater basins are contaminated to some degree.”²² Some types of contamination can be remedied, and contaminated water can be treated to remove the dangerous contaminants before delivery to its end-users; but these are not easy tasks. “Once a ground water supply is polluted, it is difficult and expensive to clean up.”²³ The total cost to clean all of California's groundwater would run into the billions of dollars.²⁴ As a result, rather than expend these enormous resources, many communities have simply stopped using their wells

completely, in favor of other, imported sources of water.²⁵ In the San Francisco Bay area, for example, “municipal, domestic, industrial, and agricultural supply wells have been taken out of service due to the presence of pollution.”²⁶

For the reasons explained above, our analysis of the contamination of California’s groundwater begins with the three main types of data available on groundwater quality: reports from the State Water Board, survey data from the Department of Health Services, and information from EPA’s and DTSC’s remediation programs regarding individual contaminated sites.

State Water Board 305(b) Report

The Clean Water Act requires the states to articulate the intended uses of every navigable water body within their jurisdictions.²⁷ In California, the uses designated for each water body are called “beneficial uses,” and they are assigned to groundwater bodies as well as to surface water bodies.²⁸ California’s 305(b) Report²⁹ assesses the health of the state’s groundwater bodies relative to the beneficial uses that the state has assigned for them. The report uses EPA’s classification of waters as: (1) not supporting their designated beneficial uses, (2) partially supporting their beneficial uses, (3) fully supporting their beneficial uses but “threatened” for at least one use, or (4) fully supporting their beneficial uses.³⁰ While, as discussed below, the 305(b) Report contains significant flaws that directly affect its conclusions, the report has represented the official view of the State Water Resources Control Board on the status of California’s groundwater basins. As such it is worth reviewing conclusions that have been published biannually by the Board with little change since the mid-1990s.

Summary of Findings. Overall Contamination. California’s “Year 2000” update to the 305(b) Report³¹ concludes that more than a third of the groundwater assessed is so polluted that it cannot fully support at least one of the beneficial uses for which it was designated.³² The 305(b) Report also lists many other groundwater basins as “Fully Supporting All Assessed Uses but Threatened for at Least One Use.” The status of these additional waters is complicated. Many of them could be in the process of becoming contaminated. The fact that they are listed as supporting most uses does not mean that there are no contaminants in the water. Including these “threatened” waters, over 40 percent of the assessed groundwater in California—nearly one-half—are listed as impaired or threatened.³³

Contaminants of Concern. The 305(b) Report categorizes impaired water bodies based on the causes of their impairment—i.e., the individual contaminants or groups of contaminants that are causing the impairment. The report states, for example, that more than 26,000 square miles of groundwater basins are impaired by salinity, and 23,500 square miles are impaired by priority organics, which are mostly volatile organic compounds (VOCs). These numbers may also include some water bodies that are categorized as “threatened” rather than “impaired.”³⁴

Sources of Impairment. The 305(b) Report also categorizes impaired water bodies based on the *sources* of their impairment—i.e., the types of activities, land uses, etc.

from which the offending contaminants originated. Sources of water pollution are often categorized as either point sources or non-point sources.³⁵ Point sources are sources with discernible, discrete conveyance points from which the pollutants are discharged. They include underground storage tanks, injection wells, and discharges from industrial and sewage treatment facilities where the discharge comes from the mouth of a pipe or other conduit.³⁶ Non-point sources release pollutants from more diffuse areas and include such activities as the application of chemicals to agricultural and urban landscapes, drainage from mining operations, timber harvesting, and sea water intrusion. In 1994, the University of California's Division of Agriculture and Natural Resources concluded that non-point sources of contamination posed the greatest threat to California's groundwater.³⁷

The source categorization in the 305(b) Report identifies activities, industries, facilities, and land uses that have contributed contaminants. Leaking underground storage tanks (LUSTs) are listed as the most pervasive source of groundwater impairment, contributing to the degradation of almost 20,000 square miles of groundwater basins in California. Natural sources, agriculture (primarily concentrated animal feeding operations), land disposal, septage, and industrial point sources are each listed as contributing to the impairment of more than 15,000 square miles of groundwater. (Groundwater basins may be contaminated by more than one source, so these numbers are not necessarily additive.) Agriculture, natural sources, land disposal,

TABLE 2
Major Findings of the 305(b) Report (2000)

MOST COMMON CAUSES OF IMPAIRMENT

The table below shows the numbers for every contaminant group listed in the year 2000 update to the 305(b) Report as causing impairment in more than 10,000 square miles of groundwater basins, or more than 10 percent of the total areal extent of waters assessed.

Cause of impairment	Areal extent of groundwater impaired by such contaminants (in square miles)^a	Areal extent of groundwater impaired as a percent of the total area assessed (62,652 mi²)
Salinity/TDS/chlorides	26,000	41.5 %
Priority Organics	23,500	37.5 %
Nutrients	16,000	25.5 %
Non-Priority Organics	16,000	25.5 %
Pesticides	11,300	18 %
Metals	10,700	17 %

^a Some of these areas inevitably overlap, as many ground water basins are impaired by multiple pollutants. Consequently, these numbers are not additive.

MOST PERVASIVE SOURCES OF CONTAMINATION

The table below shows the numbers for every source of contamination listed in the year 2000 update to the 305(b) Report as contributing to the impairment of more than 10,000 square miles of groundwater basins, or more than 10 percent of the total areal extent of waters assessed.

Source of Impairment	Total areal extent^b of groundwater impaired by each source (square miles)	As a percentage of the total assessed (62,652 sq. mi.)
Leaking Underground Storage Tanks	19,985	31.9%
Natural Sources	18,939	30.2%
Agriculture	18,313	29.2%
Concentrated Animal Feeding Operations ^c	(12,176)	(19.4%)
Land Disposal	16,402	26.2%
Septage	15,447	24.7%
Industrial Point Sources	15,218	24.3%
Resource Extraction	8,297	13.2%

^b Some of these areas inevitably overlap, as many ground water basins are impaired by contaminants from multiple sources. Consequently, these numbers are not additive.

^c Concentrated Animal Feeding Operations are a subset of the "Agriculture" category.

Source: California State Water Resources Control Board 305(b) report on water quality, (2000), pages 369–370, Tables 12A and 12B.

and septage are also listed as the most pervasive “major” contributors. The major findings in the 305(b) Report are set forth in Table 2.

Here Today, Gone Tomorrow: The Withdrawal of the 305(b) Report Groundwater Data.

After analyzing the 305(b) Report, including the regional data on which it is based, NRDC has concluded that the State Water Board’s groundwater assessment is seriously flawed in a manner that directly affects its conclusions, as discussed fully in Chapter 4. By way of summary, problems with the 305(b) Report include the age of the data, the quality and accuracy of collection methods, an apparent assumption that entire groundwater basins were contaminated when evidence of some groundwater contamination was found within a given basin, the failure to collect information on all basins within the State, and the fact that contamination is portrayed two-dimensionally, without regard to depth (*i.e.*, without regard to volume). The combination of suspected inaccuracies and incomplete statewide coverage makes it difficult to say with certainty whether the true extent of contamination is greater than or less than the results generated by a simple assessment of published data.

TABLE 3

Top Six Causes and Sources of Contamination: A Decade of 305(b) Report Groundwater Data

This table shows the areal extent of groundwater impairment in square miles from each of the top 6 causes and sources of contamination.

	1992 levels	1994 levels		1996 levels		1998 levels		2000 levels	
Areal extent of groundwater “assessed” (in square miles)	94,500	90,433		65,354		63,581		62,652	
Source		major	mod/min ^a	major	mod/min	major	mod/min	major	mod/min
Leaking Underground Storage Tanks	897	379	231	126	24,858	126	19,859	126	19,859
Natural	not listed	3,391	839	6,937	12,167	6,937	11,522	6,937	12,002
Septage	1,596 or 3,186	1,100	305	11,502	8,943	6,522	8,914	6,533	8,914
Land Disposal	759 or 1,362	132	129	481	4,431	54	5,130	5,087	11,315
Agriculture	8,370	7,947	527 ^b	11,279	10,955 ^b	6,399	10,476	6,399	11,914
Industrial Point Sources	526	428	113	715	19,383	715	14,503	715	14,503
Cause/Contaminant		major	mod/min	major	mod/min	major	mod/min	major	mod/min
Organics (priority)	910	625	287	335	22,821	335	20,821	757	22,743
Organics (nonpriority)	281	182	122	388	20,303	388	15,303	388	15,602
Salinity/TDS	4,667	3,335	1,021	11,500	12,720	11,620	12,519	11,620	14,403
Pesticides	1,909	685	12	7,500	8,489	7,500	3,489	7,500	3,829
Nitrates/Nutrients	2,238	705	391 ^c	10,800	10,097	5,920	10,097	5,920	10,094
Metals	242 + 53	20	151	4,531	6,251	4,531	5,726	4,531	6,206

^a Mod/min = moderate or minor.

^b Dairies (which are presumably a subset of agriculture) were also listed, independently, at 1087 and 20 (for 1994) and 4460 and 6017 (for 1996).

^c These numbers are listed as being for nitrates. Nutrients are listed independently at 165 and 23 for 1994.

Source: California State Water Resources Control Board 305(b) report on water quality, (1992–2000).



State Water Resources Control Board

Division of Water Quality

1001 I Street • Sacramento, California 95814 • (916) 341-5455
 Mailing Address: P.O. Box 94213 • Sacramento, California • 95834-2130
 FAX: (916) 341-5463 • Internet Address: <http://www.swrcb.ca.gov>



MAR 22 2001

Ms. Janet Hashimoto (WTR-2)
 U.S. Environmental Protection Agency,
 Region 9
 75 Hawthorne Street
 San Francisco, CA 94105

Mr. Bill Vance
 California Environmental Protection Agency
 1001 I Street
 Sacramento, CA 95814

Mr. Alex Helprin
 Natural Resources Defense Council
 6310 San Vicente, Suite 250
 Los Angeles, CA 90048

Dear Ms. Hashimoto, Mr. Vance, and Mr. Helprin:

GROUNDWATER ASSESSMENT INFORMATION IN THE 2000 CALIFORNIA 305(b) REPORT ON WATER QUALITY

A copy of the State Water Resources Control Board's (SWRCB) 2000 California 305(b) Report on Water Quality (305(b) Report) was mailed to you recently. Subsequently, SWRCB staff discovered that the information on groundwater assessment, in particular the size of groundwater impairment, is not correct. An errata sheet (enclosed) is being included in the report on page 368 clarifying the mistake and retracting the information. We request that you paste this sheet to your copy of the 305(b) Report.

We recommend that you do not quote or cite the information on the size of groundwater impairment presented in the SWRCB's 2000 305(b) Report. The SWRCB staff is currently verifying and updating this information.

Please call me at (916) 341-5458 if you have any questions on this subject. You may also call Nancy Richards, the staff member most knowledgeable on this subject, at (916) 341-5546.

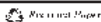
Sincerely,

Stan Martinson, Chief
 Division of Water Quality

Enclosure

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Web site at <http://www.swrcb.ca.gov>

California Environmental Protection Agency



Enclosure

March 15, 2001

Retraction of Groundwater Assessment Information

State Water Resources Control Board (SWRCB) staff is retracting all groundwater assessment information from the SWRCB's year 2000 federal Clean Water Act (CWA) Section 305(b) report. The reason for this decision is that the data on the size of groundwater impairment (columns 5 and 7 in Appendix C) are not correct. In almost all cases, the total size of the groundwater basin (column 8 in Appendix C) is assumed to be impaired, leading to a gross overestimation of groundwater impairment in California.

The summary information on the size of groundwater impaired by various cause and source categories presented in Tables 12A and 12B, respectively, should be disregarded since it is based on the faulty information of Appendix C.

It should also be noted that the groundwater assessment information in the WBS database has not been updated since 1992. SWRCB staff is in the process of verifying and updating the groundwater assessment information.

Please call Nancy Richard at (916) 341-5546 if you have any questions on this subject.

DISAPPEARING DATA

On March 22, 2001, following receipt of an advance draft of this NRDC report, the State Water Resources Control Board wrote a letter to the Natural Resources Defense Council, the United States Environmental Protection Agency, and the California Environmental Protection Agency. In the letter, the Board took the unprecedented step of withdrawing all of the groundwater data in the 305(b) Report.

The State Water Resources Control Board has published this suspect groundwater information in substantially the same form since 1996. See Table 3. However, in response to an advance copy of this NRDC report, senior staff at the State Water Board recently took the unprecedented step of withdrawing all of the groundwater assessment information presented in the 305(b) Report. In a March 22, 2001 letter to NRDC, the United States Environmental Protection Agency and the California Environmental Protection Agency, the Board stated that assessments regarding the size of groundwater impairment, as well as information about sources and contaminants of concern, should be disregarded in their entirety (see sidebar, “Disappearing Data”). The Board further admitted that, notwithstanding the biannual requirement to publish the groundwater assessment, it had not updated the report since 1992, nearly a decade ago.

It is unclear why the State Water Resources Control Board compiled and then republished for at least five years data it believes to be grossly flawed. It is also unclear why the Board failed to update its report for nearly a decade, an omission it acknowledged on March 22, 2001. NRDC’s investigation into the 305(b) Report, and NRDC’s transmittal of an advance copy of this report to the Water Board, appears to have triggered perhaps the first consideration of the report by the Board in some time, which quickly led to the retraction of data published for the third time only a few months earlier. While staff claim to be reassessing the information on which the 305(b) Report is based, and may come under political pressure to reinstate the assessment soon, the errors in the 305(b) Report cannot be easily or quickly remedied. As discussed further in Chapter 4, the groundwater assessment in the 305(b) Report is rife with thoroughgoing methodological and data inadequacies. The Board’s awareness of these problems, however, could, or at least should, lead to a full-scale reformation of the critically important groundwater assessment in the 305(b) Report.

Department of Health Services Information on Drinking Water

If the State Water Resources Control Board’s 305(b) Report is intended to be a source of broad-scale information on contamination in California’s groundwater basins, the Department of Health Services provides more focused information. The Department of Health Services (DHS) assesses threats to drinking water sources and collects water quality data from every drinking water source that serves at least a certain minimum number of people. Examining DHS data therefore yields a useful portrait of the quality of that portion of California’s groundwater supplies that is used for drinking water.

Drinking Water Database. DHS, in accordance with the California Safe Drinking Water Act, oversees the monitoring of every public water system, meaning all systems having at least 15 service connections or that serve at least 25 people for at least 60 days in a row each year. It also collects information from counties on systems serving between 5 and 15 connections.³⁸ Private residential wells and wells that do not fit the aforementioned criteria are not monitored by DHS but may be monitored at the local level.³⁹ The Department collects information from water providers all

over the state and compiles it in a massive "Drinking Water Database." When a drinking water supplier fails to report required data, Department engineers follow up.⁴⁰

The Department's Drinking Water Database, which is cumulative and extends back to about 1984, includes information on more than 28,000 distinct water sources (covering both surface and groundwater sources), which serve (or served) almost 12,000 water systems. More than 25,000 of those 28,000 water sources are subterranean (groundwater). NRDC obtained a copy of this database in October of 2000, isolated the data coming from groundwater sources and focused on the most recent 12 months of data: from October 1999 to October 2000.⁴¹ In that one year of data, the Department collected information from about 7,100 distinct groundwater sources, supplying about 2,175 separate water systems throughout the state.

For the one-year period reviewed, the database contains more than 600,000 data points, each point representing the result of a single analysis performed on one of the

FIGURE 5

Drinking Water Sources That Exceeded Maximum Contaminant Levels

This map displays the location of drinking water sources (groundwater wells only) with at least one contaminant that exceeded a state drinking water standard, as reported to the Department of Health Services, between October 1999 and October 2000.

Source: Data from the Department of Health Services (DHS) Drinking Water Database (October 1999–October 2000); compiled by LFR Levine-Fricke; mapped by NRDC.

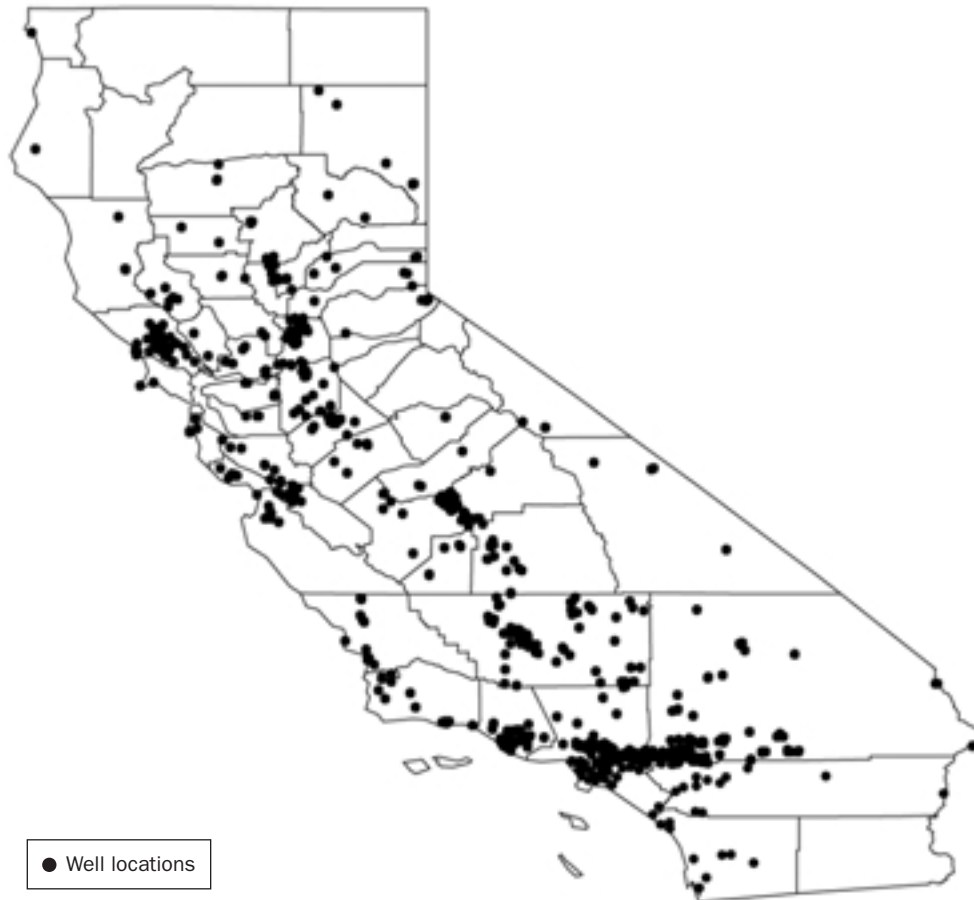


TABLE 4**Contaminants Detected Above Maximum Contaminant Levels**

The Department of Health Services compiles water quality data from drinking water sources across the state. It also sets drinking water standards (MCLs) for many contaminants. This table shows those contaminants in groundwater wells that were most often detected exceeding their MCLs between October 1999 to October 2000.

Source: Department of Health Services Drinking Water database (October 1999–October 2000); as compiled by LFR Levine-Fricke.

Contaminant	Number of samples that exceeded the MCL for this contaminant
Nitrate (as NO ₃)	1812
Manganese	989
Trichloroethylene	650
Dibromochloropropane (DBCP)	582
Tetrachloroethylene	591
Iron	394
Carbon Tetrachloride	249
Fluoride (temperature dependent)	243
Gross Alpha	197
Turbidity, Laboratory	114
Nitrate + Nitrite (as N)	108
Color	91
Uranium	89
Ethylene Dibromide (EDB)	55
TDS	52
1,1-Dichloroethylene	49
1,2-Dichloroethane	38
Odor Threshold	36
Chloride	35
Arsenic	32
Benzene	27
Specific Conductance	23
Sulfate	22

groundwater samples taken from one of the 7,100 wells. More than one percent of those data points (over 6,500) contain a contaminant that exceeds state drinking water standards (MCLs).⁴² The locations of almost 90 percent of the samples that exceeded MCLs are widely distributed across the state (see Figure 5).⁴³ The top five offenders were nitrate, manganese, TCE/PCE (trichloro/tetrachloro-ethylene), DBCP (dibromochloropropane), and iron (see Table 4).

Drinking Water Source Assessment and Protection Program. The Department of Health Services is also in charge of another program designed to assess the vulnerability of the state's drinking water sources. The Drinking Water Source Assessment and Protection Program⁴⁷ is the state's first comprehensive and preventive strategy for managing drinking water source areas and, as such, should be commended for its

WHAT HAPPENS WHEN CONTAMINANTS ARE DETECTED?

When contaminants are detected in a drinking water supply at or above specified levels, state water engineers refer to Department of Health Services regulations to determine the appropriate response.⁴⁴ Whenever any contaminant is first reported, a second sample is required for confirmation. Thereafter, a different policy applies depending on the type of contaminant and the concentration level at which it is detected.

For example, if a VOC is detected but is measured at a level below half the applicable maximum contaminant level (MCL),⁴⁵ the state requires annual monitoring for it. Once a contaminant occurs at a level above half the MCL, tests must be conducted on a quarterly basis. If it exceeds the MCL, the supplier may still continue to deliver the water but must test on a monthly basis for 6 months and report the average of these tests. If the average of the tests exceeds the MCL, then the water system is considered to be “out of compliance,” and it receives a formal citation that prevents continued use of the source for drinking water.⁴⁶

For acute constituents such as total or fecal coliform, a confirmed finding calls for additional tests for *Escherichia coli*. If *E. coli* is detected, the water system must be closed immediately until *E. Coli* is removed. Absent a detection of *E. coli*, monthly tests must continue and repeat detections of coliform result in a citation ordering the supplier to cease distributing drinking water.

The presence of contamination in the source water does not necessarily require the closure of a groundwater well. Water systems can implement water treatment accompanied by monthly monitoring for contaminants and/or may blend the problematic water with other “cleaner” water in order to reduce the concentration of the contaminants of concern in the water that is ultimately to be delivered to the end-users. If water is treated or blended to produce water that is below the MCL, the supplier is not considered to be “out of compliance.” However, under some circumstances, water systems may continue to deliver water even though it is out of compliance. If they have no other source of water, water companies may continue to provide water that exceeds an MCL as long as they continually notify the recipients of the violation until the problem is abated.

scope and goals. As it is currently structured, it is designed to identify potentially contaminating activities⁴⁸ in the vicinity of drinking water sources by accomplishing the following three major tasks:

- ▶ delineating the areas around drinking water sources through which contaminants might be able to travel to reach the drinking water supplies;
- ▶ developing an inventory of ongoing activities, known as possible contaminating activities (or “PCAs”), that could release contaminants within those delineated areas; and
- ▶ determining, for each drinking water source, “the PCAs to which the drinking water source is most vulnerable”⁴⁹

Program work began fairly recently, with the Department having received final program approval from the U.S. Environmental Protection Agency in November 1999. As of April, 2000, the program had reportedly assessed more than 100 drinking water sources in 19 different counties.⁵⁰ However, those numbers pale in comparison

to the task at hand: By the Department's own estimation, there are approximately 16,000 active drinking water sources in the state, as well as several thousand sources in standby and inactive modes.⁵¹ Although the Department reports that it expects to complete assessments of all the active water sources by May of 2003, its current pace would suggest otherwise.

EPA/DTSC Information on Designated Cleanup Sites

Groundwater often becomes contaminated as a result of an accidental release of hazardous substances at a site that subsequently (once the release is discovered) becomes the subject of a major cleanup action. As released materials move through the subsurface, they often end up contaminating nearby aquifers, unless they are discovered early on and the site is promptly remediated.

Of course, a one-to-one correlation between "cleanup sites" and groundwater contamination cannot be assumed. However this report considers such sites to be potential, if not likely, areas of affected groundwater resources. This inference is supported by the fact that, in the process of evaluating potential sites for federal cleanup funding, the Environmental Protection Agency (EPA) does not limit its investigation to soils but specifically focuses on the status of groundwater resources as well.⁵² Furthermore, although groundwater is often affected, cleanup action is rarely fully effective at restoring groundwater basins to their natural condition.⁵³

Any individual can report a spill or leak of potentially hazardous materials to the federal EPA or to the state's equivalent, the Department of Toxic Substances Control (DTSC). In addition to overseeing cleanup actions, these agencies maintain databases of all potential cleanup sites, regardless of the source of the contaminants.

Federal System. When a site is brought to the attention of the EPA, it is subjected to two levels of screening before it can reach the National Priorities List (NPL) and thus become eligible for funding under the Superfund program.⁵⁴ First, sites are evaluated for initial entry into EPA's CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Information System) database.⁵⁵ A site will not be included in CERCLIS if, among other reasons: (1) the substance(s) released at the site are excluded from coverage under the law or by policy considerations; (2) the site is in the final stages of cleanup under the jurisdiction of another entity, such as a state or tribal program; or (3) there are insufficient data to determine if CERCLIS entry is appropriate.⁵⁶ Statutorily excluded substances include petroleum products, natural gas, fertilizers released through normal application, and substances that are regulated by a different agency, such as the Nuclear Regulatory Commission. Policy exclusions usually refer to exclusions for sites that fall under EPA's jurisdiction under the Resource Conservation and Recovery Act, Subtitle C.⁵⁷ There is no single repository for information on sites that do not pass the pre-CERCLIS screening process.⁵⁸

Once a site is listed in the CERCLIS database, it is further evaluated to determine whether it will be placed on the National Priorities List. This evaluation is conducted pursuant to EPA's National Contingency Plan regulations. If, after a site inspection, the site is considered a candidate for a thorough evaluation and "scoring" under the

FIGURE 6

Drinking Water Sources and Superfund Sites

The Environmental Protection Agency (EPA) has placed 94 California sites on its National Priorities List (NPL). This map shows the locations of these NPL sites and the approximately 100 other sites currently being considered for NPL status, and their proximity to sources of drinking water. Drinking Water Supply sites are locations of public water supplies, their intakes, and sources of surface water supply.

Source: U.S. EPA BASINS and CERCLIS databases; compiled by LFR Levine-Fricke.



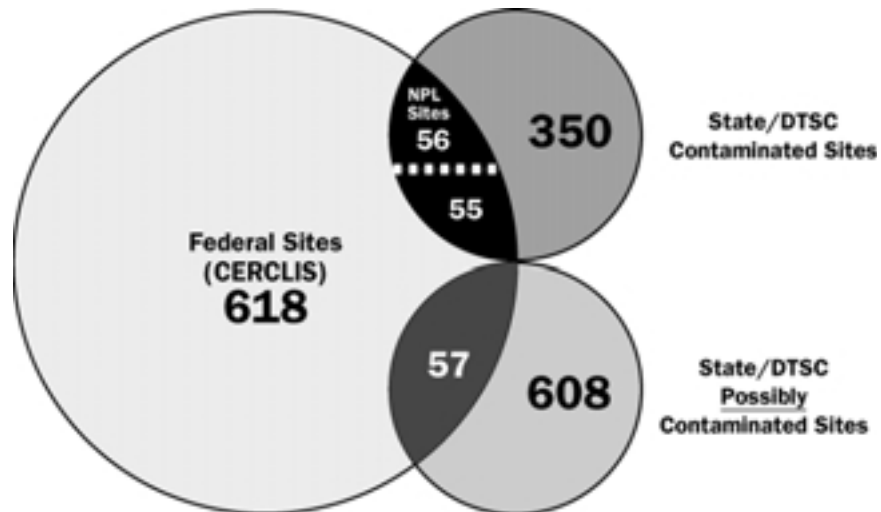
hazard ranking system, and it receives a score of 28.50 or above, it will be included in the NPL.

As of January 22, 2001, there were approximately 787 sites in California that were on the CERCLIS database—94 of which had already been classified as NPL sites and the remainder of which were presumably either awaiting investigation or being investigated.⁵⁹ Figure 6 shows the locations of the 94 NPL sites in relation to sources of drinking water.⁶⁰ The CERCLIS database does not provide coordinates for non-NPL sites, so they could not be plotted.

FIGURE 7**State and Federal Cleanup Sites**

A number of cleanup sites appear in both the U.S. EPA (CERCLIS) database and the California Department of Toxic Substances Control (DTSC) database. Many others, however, are recognized by one program but not the other. DTSC reports sites as "possibly contaminated" when a hazardous substance release is suspected and as "contaminated" after a release is confirmed.

Source: Department of Toxic Substance Control (DTSC) CalSites database and U.S. EPA CERCLIS database.



Sites that make it onto the CERCLIS database but do not make the NPL are removed from CERCLIS and entered into another database, for sites where there is "No Further Remedial Action Planned" (the NFRAP database). As of January of 2001, almost 2,600 California sites had been moved out of CERCLIS to the NFRAP database. It is important to note that this listing does not necessarily mean that these sites do not involve soil and water pollution; they simply do not do so to the extent and in a manner that EPA considers sufficient to warrant federal attention.

State System. At the state level, the number of sites is just as high. The California Department of Toxic Substances Control maintains its own database, entitled CalSites, which groups potential cleanup sites into several categories. As of May of 1998, 4,150 parcels of property were listed in the database. Most of these sites (2,578 of the 4,150 sites in the database, about 62 percent) were assigned to other agencies for review. Of the remaining 1,572 sites, 326 (more than 20 percent) had been confirmed as sites of uncontrolled releases of hazardous substances requiring remediation.⁶¹ The 2,578 reassigned sites may or may not be in need of some cleanup. A thousand of these re-assigned sites (that is, 40 percent) were deemed a possible threat to surface or groundwater and were, therefore, referred to the appropriate Regional Water Quality Control Board. Most of these sites fell into the categories of abandoned mines, leaking underground fuel tanks, toxic pits, or leaking solid waste landfills.⁶²

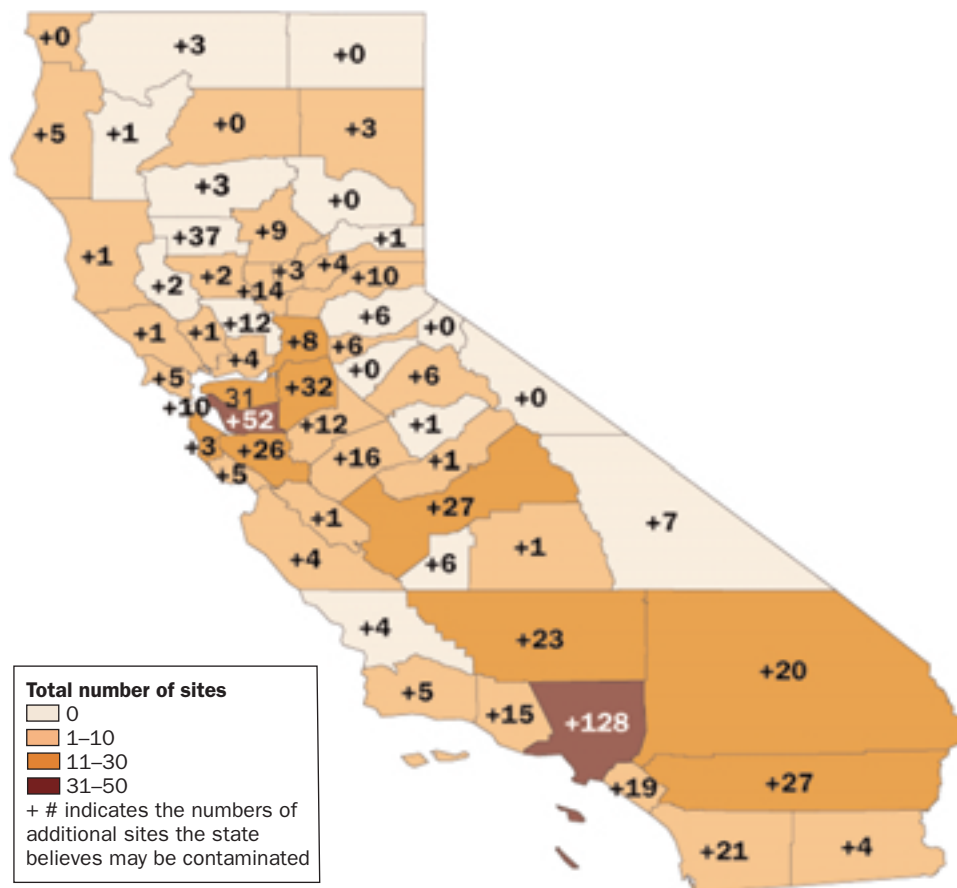
More than 300 sites had been certified as being satisfactorily remedied, but more than 80 of those required continuing, long-term operation and maintenance.⁶³ Nearly

FIGURE 8

State Cleanup Sites by County

This map shows the relative number of contaminated sites on the state cleanup list in each county in California. Each site is the location of an uncontrolled release of hazardous substances. The numbers in each county represent additional suspected contaminated sites.

Source: Data from Department of Toxic Substances Control (DTSC) CalSites database; compiled by NRDC.



300 more were listed as being in need of a preliminary endangerment assessment to determine whether or not a release of hazardous substances had occurred.

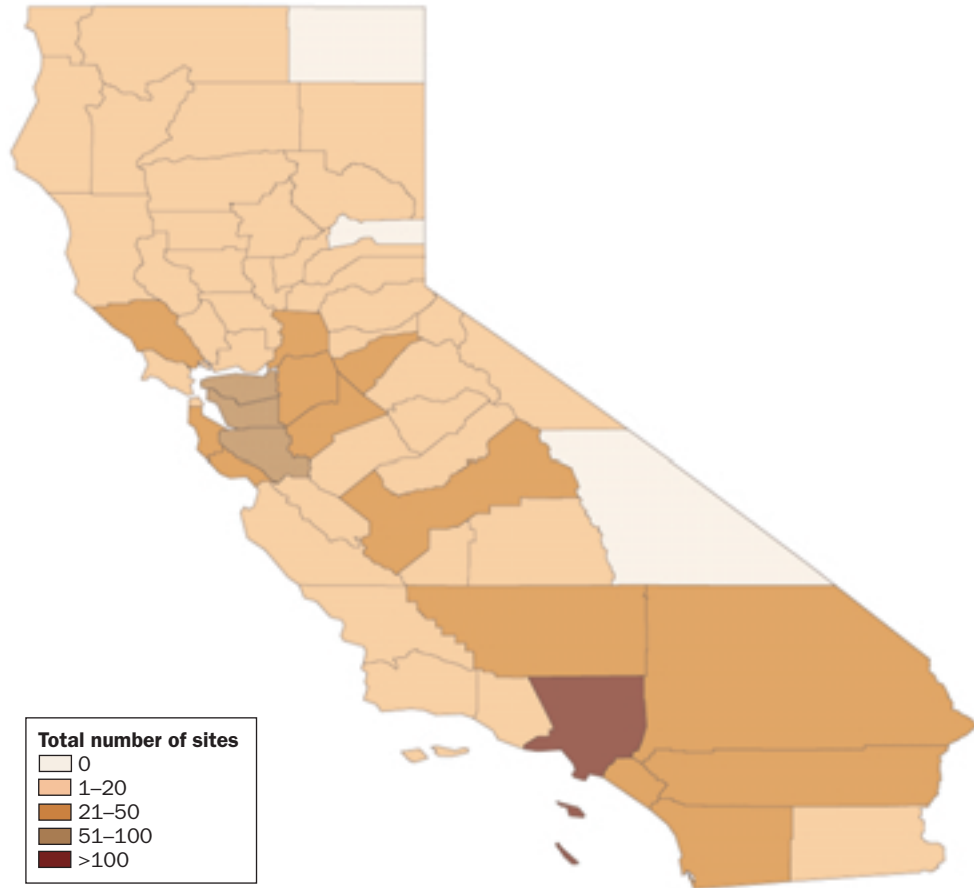
NRDC commissioned two special reports from the Department of Toxic Substances Control in December of 2000 to update this information. The first report isolated only those categories of sites with confirmed uncontrolled releases of a hazardous substance(s), indicating the existence of a public health and/or environmental threat and that cleanup was warranted. The other report listed only those cleanup sites in categories that indicated suspected releases. As of December 21, 2000, the number of sites with confirmed releases had risen to 461 (111 of which are also listed on the CERCLIS database). The second report showed 665 sites with suspected releases (57 of which were also on the CERCLIS database). Figure 7 shows the extent of overlap between the state and federal databases.

Among California's 58 counties, only 19 contain no state Superfund sites. Figure 8 shows the approximate number of cleanup sites in each county of California, as of

FIGURE 9**Total Federal and State Cleanup Sites by County**

This map displays the relative number of federal and state cleanup sites located in each county in California.

Source: Data from Department of Toxic Substance Control (DTSC) CalSites database and U.S. EPA CERCLIS database.



December 21, 2000. The numbers written in each county represent additional, possibly contaminated sites. Although the CERCLIS database does not list coordinates for all of its sites, it does list the county in which each site is located, allowing the CalSites and CERCLIS data to be aggregated. Figure 9 combines the state and federal data, weeding out the overlap, and shows the total number of sites known to be contaminated in each county.

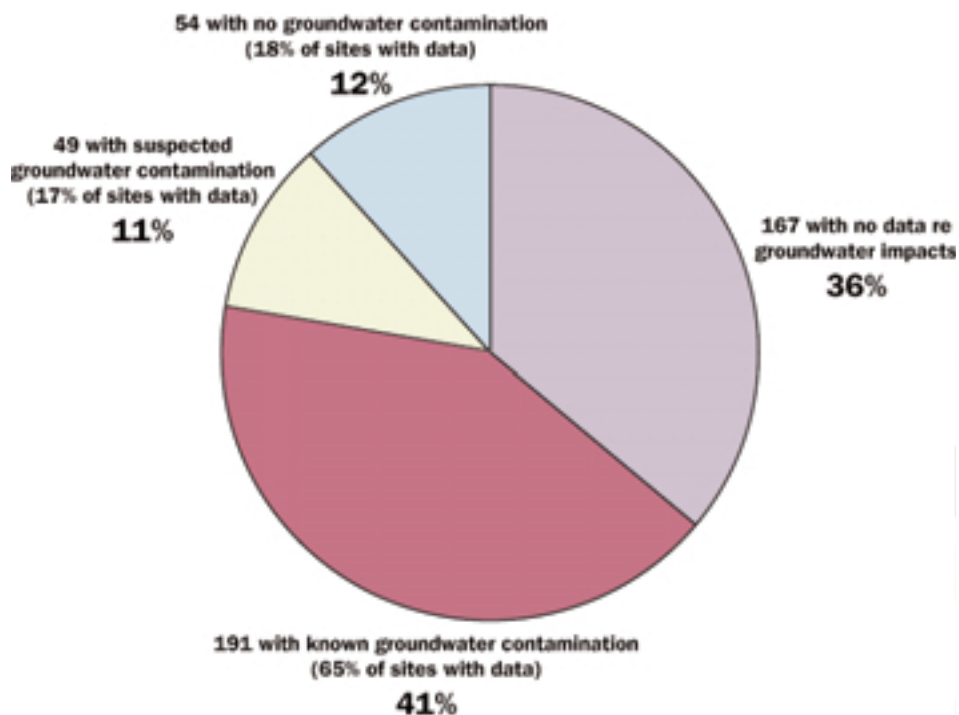
The CalSites database includes information for some of the sites on whether there has been an impact to groundwater. However, such data are available for only 294 of the 461 sites with known releases—slightly under two-thirds. Of those 294 sites, 191 (or 65 percent) have known groundwater contamination. Another 49 (or 17 percent) have suspected groundwater contamination. Only 18 percent (54 sites) are confirmed to have no groundwater impact—yet (see Figure 10). If one were to assume that the sites of suspected groundwater contamination do, indeed, have contaminated groundwater, and the sites without data break down in the same proportions as the known data, more than 80 percent of these cleanup sites would have affected groundwater.

FIGURE 10

Groundwater Impacts at DTSC Cleanup Sites

The Department of Toxic Substances Control (DTSC) has confirmed the release of toxic substances at 461 sites but has only analyzed potential impacts to groundwater at 294 of these sites. The contamination is known to have reached the groundwater at two-thirds of these sites and suspected to have done so at many more.

Data from Department of Toxic Substance Control (DTSC) Calsites database; compiled by NRDC.



Conclusion

The three sources of information discussed above reveal a significant amount of contamination of California's groundwater basins. The State Water Board's 305(b) Report lists a series of different types of contaminants each of which impairs a major portion of California's groundwater basins according to standards set by one or more of the agencies of the state itself. This information, however, is of questionable accuracy and, at least for now, has been withdrawn in response to NRDC's investigation. The Department of Health Services' Drinking Water Database shows that these same types of contaminants have reached drinking water wells, causing several thousand drinking water standard exceedances in the last year alone. Finally, the records of cleanup sites maintained by the federal Environmental Protection Agency and the California Department of Toxic Substances Control show the distribution of locally extreme contaminated sites across the state. These data confirm that contamination is widespread in the state—virtually no region or area is immune from one or another groundwater impairment problem.

DOWN AND DIRTY: CALIFORNIA'S CONTAMINATED AQUIFERS



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

This chapter is divided into two sections. The first examines the distribution and extent of contamination of California's groundwater by five pervasive and significant types of contaminants. The second section explores the impacts of the major sources of those contaminants (e.g., agricultural practices).

SPECIFIC CHEMICALS AND GROUPS OF CHEMICALS

This section presents information regarding the extent and distribution of five significant contaminants in California's groundwater, along with a specific focus on an area of the state in which each type presents a particular problem. NRDC selected these contaminants—salinity, organic compounds, nitrates, pesticides, and metals—for multiple reasons. First, these five contaminants include both naturally occurring and anthropogenic substances, reflecting the fact that both anthropogenic and natural contamination of groundwater resources are serious issues in California, often in an interrelated manner. Second, these contaminants—some of which are associated with agriculture (and the least industrialized parts of the state), and some of which result from industrial activities (and are found in the most urbanized parts of California)—represent a range of human and other influences. The prevalence of these contaminants is therefore more indicative of the overall extent of groundwater contamination than a study of a narrower set of contaminants associated with a particular activity or natural condition. Third, although a precise ranking of the most pervasive contaminants is precluded by errors and omissions in California's 305(b) Report, the types of contaminants are important influences on groundwater quality within the state. Of course, groundwater is threatened and impaired by dozens, if not hundreds, of contaminants, and a review of each of them is beyond the scope, and the purpose, of this report. By selecting a sample of contaminants, however, it is possible to assess in general terms the impact of a range of human and natural influences on groundwater quality.

Salinity

“Water, water, everywhere, Nor any drop to drink.”¹ The famous line from Samuel Taylor Coleridge’s “Rime of the Ancient Mariner” evokes images of sailors adrift at sea, but it has increasingly broader application. Today, higher and higher levels of salts appear in California’s groundwater, threatening to render the water in many aquifers unsuitable for human consumption or agricultural use.

Between 400,000 and 700,000 acres of arable land are expected to be lost by the year 2010 due to increasing salinity, resulting in a loss of somewhere from 32 to 320 million dollars per year.² The nature, origins, and impacts of increasing salinity are discussed below, followed by a few examples of areas that have been particularly hard hit.

Background. Salinity is based on the total concentration of dissolved ions in a water body, rather than on the presence of any one constituent. Saline waters contain compounds made up of highly water-soluble, charged particles such as sodium (Na^+), potassium (K^+), calcium (Ca^{+2}), and chloride (Cl^-). Other negatively charged ions can be in non-elemental forms, such as certain forms of boron (e.g. borate, BO_3^{-3}) and selenium (selenate, SeO_4^{-2}), though these are less common.

Water with less than 1,000 milligrams of total dissolved solids per liter is considered freshwater.³ The Environmental Protection Agency has set the maximum contaminant level for human consumption⁴ at 500 milligrams per liter (mg/L) of total dissolved solids. Water intended for agricultural uses can be somewhat higher in dissolved solids but still cannot exceed a limit that ranges from about 500 to 1500 mg/L, depending on the specific crop.⁵

As a result of California’s geologic history, many of California’s soils and shallow groundwater basins are naturally high in salts.⁶ For example, the sedimentary rock of the Coast Range Mountains is heavily laden with salts because the mountains were created from uplifted layers of marine sediment.⁷ Streams flowing from the Coast Range into the San Joaquin Valley eroded that sedimentary rock and deposited high levels of salts in the alluvial soils along the entire western edge of the Valley.⁸

However, human activity has also had a dramatic impact on the level of salts in many areas. Irrigated agriculture, in particular, has led to the concentration of salts, because only pure water⁹ will evaporate or be transpired by plants. Thus, if irrigation water is not totally pure, evaporation and evapotranspiration will remove the moisture and leave behind any dissolved salts and minerals either to sink into the subsurface or to accumulate on the surface. With repeated applications, the salts become progressively more concentrated.

If too much salt collects in the root zone, farmers may try to flush it out in order to protect their crops, as high concentrations of dissolved solids decrease plant growth and crop yields.¹⁰ If alternate drainage paths are not provided, this flushing process will convey the salinity from the root zone directly down to the water table where it will enter the groundwater. This has occurred on the west side of the San Joaquin Valley, where large quantities of naturally occurring salts have been forced from the soil down to the water table.¹¹ Shallow irrigation wells exacerbate this problem by recirculating saline groundwater and expediting the concentration process.¹²

Between 400,000 and 700,000 acres of arable land are expected to be lost by the year 2010 due to increasing salinity, resulting in a loss of somewhere from 32 to 320 million dollars per year.

Agricultural irrigation water also *picks up* salts through the addition of fertilizers or soil amendments.¹³ Here, too, concentrations of these additives are increased as the applied water evaporates.

Wastewater discharges from agriculture *and municipal* sources can also contain significant amounts of salinity. Although municipal wastewater originating from domestic uses generally receives some degree of treatment, not all of the salts are removed, and residual salts are carried to the aquifer when this water is used for groundwater recharge.

Finally, along the coast, human activity has led to saltwater intrusion into many aquifers. Saltwater intrusion is the movement of saline water that displaces or blends with freshwater in an aquifer. Under natural conditions, freshwater in coastal aquifers flows towards the ocean and prevents saltwater from invading the aquifers. When freshwater in these aquifers is withdrawn at a rate faster than it can be replenished, the water table is lowered and the direction of groundwater flow can be reversed. When this happens near an ocean, seawater is drawn into the freshwater aquifer.

Saltwater intrusion can occur wherever an area of highly saline water is hydraulically connected to an aquifer with a lower salt content. In California, zones of highly saline groundwater underlie many freshwater aquifers. When a well pumps groundwater out of the freshwater zone, the underlying saltwater can migrate upward in a phenomenon known as upconing or upwelling. This can occur whether or not the withdrawals constitute overdraft, but the effect is more pronounced with increases in the amount of water pumped. This phenomenon has occurred in California's Central Valley.

Impacts. Highly saline water cannot be used as drinking water, as it robs the body's tissues of needed water by causing water to diffuse across the membranes of one's alimentary canal through osmosis. Similarly, water with excessive levels of dissolved solids will not work for irrigation purposes, as discussed above.¹⁴

Furthermore, even water that is only slightly saline, and is therefore delivered for public use, can have negative economic impacts. For example, an estimated \$100 million in direct and incidental expenses is incurred for every 100 milligrams of salt per liter that appears in the domestic water supply. These costs include water treatment, water loss, and pipe maintenance (as salt corrodes and clogs pipes).¹⁵ Southern California alone accumulates more than 600,000 tons of salt every year as a result of agricultural activities, urban run-off and imported water sources.¹⁶ Given the costs of addressing these salinity issues, local and state government agencies in California have begun requesting additional funding from federal sources.¹⁷

CASE STUDIES: SALINITY PROBLEMS IN VENTURA AND KERN COUNTIES

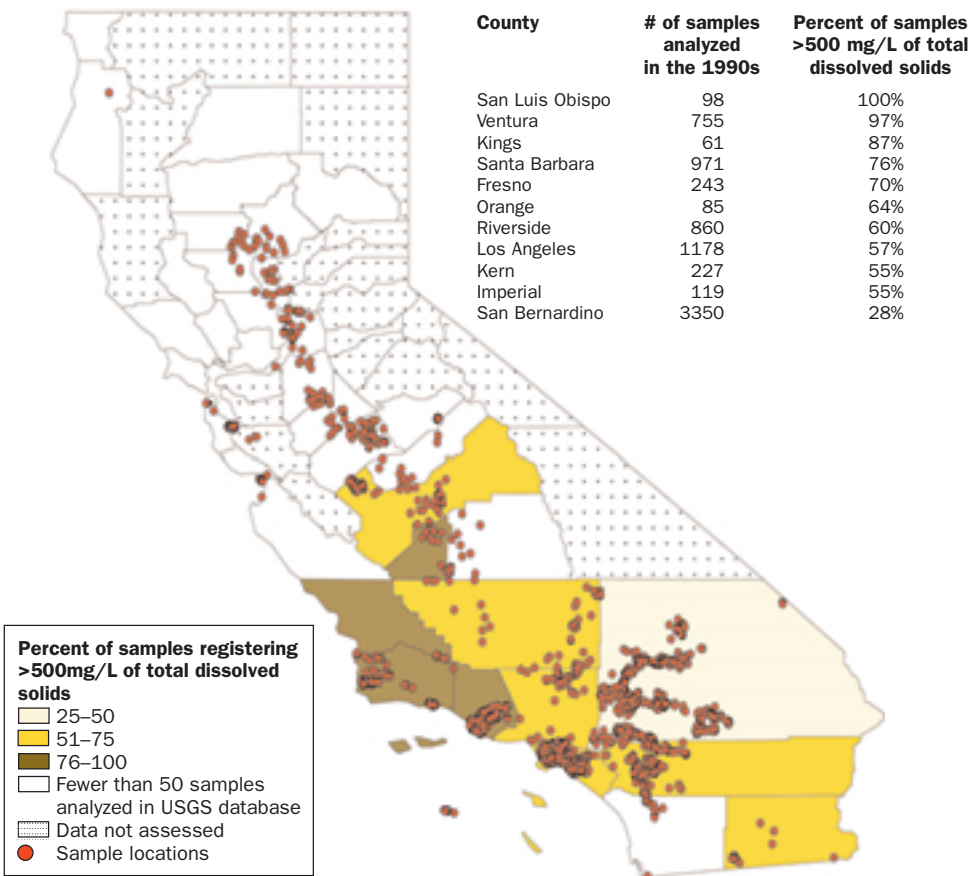
NRDC used data from the U.S. Geological Survey (USGS) to determine relative salinity levels in groundwater basins across California.¹⁸ NRDC obtained data from about 85 percent of the sites in the USGS's California database, representing all the sites in 37 of California's 58 counties.¹⁹

FIGURE 11

Salinity in California Groundwater

Both the state and federal governments have set a 500 mg/L secondary drinking water standard (see Glossary) for salinity in drinking water. NRDC reviewed 10 years of groundwater quality data (1990 to 2000) from the U.S. Geological Survey (USGS) for 38 of California's 58 counties and calculated the number of samples that exceeded that threshold. For any county in which USGS analyzed more than 50 samples over that 10-year period, this map shows the percent of those samples that exceeded the 500 mg/L limit. The USGS did not sample randomly throughout the state, and the samples were not designed to be representative of entire counties. However, it is the most comprehensive data available.

Source: Data from U.S. Geological Survey (1990–2000); compiled by NRDC.

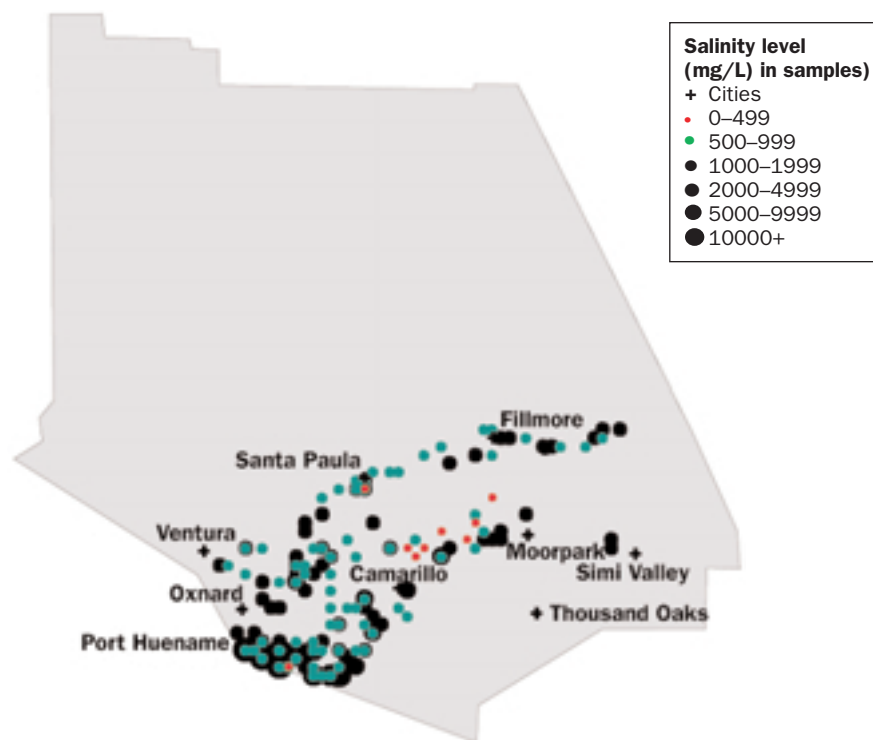


The map in Figure 11 reflects salinity levels in several California counties, based on the USGS data for the period 1990 to 2000. Only those counties for which there were a significant amount of data are represented in Figure 11. The others are either blank (if the data were insufficient)²⁰ or spotted (if data were not requested for those counties). Sample points are indicated by large dots. In each county in which sufficient data were available, the shading reflects the percentage of the samples taken that exceeded 500 milligrams per liter of total dissolved solids—the standard set by the Environmental Protection Agency and the approximate point at which taste is affected.²¹ As indicated on the key, the darker the shading, the higher percentage of samples above the MCL. As the figure indicates, high salinity levels are a problem along the southern coast, throughout Southern California, and in the Central Valley.

FIGURE 12**Salinity in Ventura County Groundwater**

Based on the information presented in Figure 11, NRDC chose Ventura County as an example of a coastal county with significant salinity impairment of its groundwater. This map shows the approximate salinity level of every groundwater sample taken between 1990 and 2000 for which the U.S. Geological Survey has usable data. Both the state and federal governments have set a secondary drinking water standard, or “maximum contaminant level” (MCL), for salinity in drinking water at 500 mg/L. (See Glossary for a discussion of drinking water standards.) Only the samples represented by the red dots on this map are below that threshold. California’s 500 mg/L threshold is described as a “recommended” MCL, with a separate “upper” MCL of 1,000 mg/L. The green dots represent samples that exceeded the federal threshold but were in this “gray area” under state law. The blue dots show the locations of samples that exceeded both drinking water limits.

Source: Data from U.S. Geological Survey (1990-2000); compiled by NRDC.



Because the primary sources of salinity contamination are from seawater intrusion and agricultural practices, two counties were selected for case studies—one along the coast (Ventura County) and one in the Central Valley (Kern County).

Ventura County. In the late 1940s, increased groundwater use for agriculture and related processing operations in the Oxnard Plain reduced groundwater elevations, resulting in seawater intrusion. As the map in Figure 12 shows, salinity has intruded from the coast deep into Ventura County. Near the coast, levels can be well into the tens of thousands of milligrams per liter. Further inland, the levels are lower, but they still exceed the MCL by a substantial amount. Levels in the thousands are also recorded much further inland, in the agricultural areas around Fillmore and Moorpark.

Steps have been taken locally to address the seawater intrusion. In 1991, the United Water Conservation District constructed the Freeman Diversion Improvement Project, which increased Santa Clara River diversions in an effort to reduce agricultural

dependence on groundwater. The diverted water is also used for groundwater recharge to help offset groundwater demand and prevent further reduction of the water table. In addition, agricultural and urban water conservation measures such as ordinances requiring meter installation on high-volume wells and the restriction on drilling new wells in some areas have reduced demand. Currently, groundwater extractions approximately equal recharge, and the saltwater intrusion has been halted.²²

Kern County. The San Joaquin Valley has been an agricultural center for many decades. Figure 13 shows the salinity levels recorded in over 200 individual samples taken in Kern County from 1990 through 2000. The map shows salinity levels in excess of 1,000 mg/L in the eastern section of the county, around Ridgecrest, in the North, above Wasco, and below the two central cities of Oildale and Lamont. The figure shows the widespread distribution of the salinity problem in Kern County.

Notably, as a general principle the U.S. Geological Survey has concluded that the deeper beneath the surface one samples in the Central and San Joaquin Valleys, the worse the salinity is (i.e. the greater concentration of dissolved solids one is likely to encounter).²³

Organics

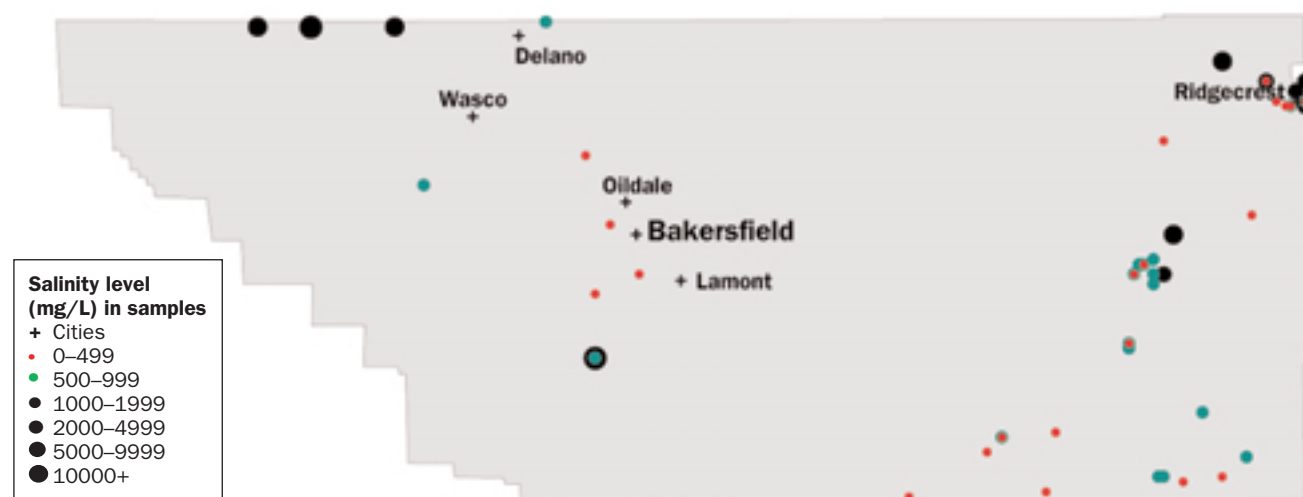
Background. The phrase “organic compound” simply refers to a chemical compound that contains both hydrogen and carbon atoms. There are many different parameters along which organic compounds can be categorized. They are often classified based

FIGURE 13

Salinity in Kern County Groundwater

Based on the information portrayed in Figure 11, NRDC chose Kern County as an example of an inland county with significant salinity impairment of its groundwater. This map shows the approximate salinity level of every groundwater sample taken between 1990 and 2000 for which the U.S. Geological Survey has usable data. Both the state and federal governments have set a secondary drinking water standard, or “maximum contaminant level” (MCL), for salinity in drinking water at 500 mg/L. (See Glossary for a discussion of drinking water standards.) Only the samples represented by the red dots on this map are below that threshold. California’s 500 mg/L threshold is described as a “recommended” MCL, with a separate “upper” MCL of 1,000 mg/L. The green dots represent samples that exceeded the federal threshold but were in this “gray area” under state law. The black dots show the locations of samples that exceeded both drinking water limits.

Source: Data from U.S. Geological Survey, (1990–2000); compiled by NRDC.



on whether they are toxic or non-toxic, synthetic or non-synthetic (a distinction with less meaning now that technology has enabled the synthesis of some naturally-occurring organics), aromatic or non-aromatic, halogenated or non-halogenated, or volatile or non-volatile. Many of these categorization schemes overlap. Thus, some volatile organic compounds are aromatic and some are not, while some aromatic organics are volatile and some are not. Similar divisions exist among the halogenated organics and others.

This discussion of organics focuses on volatile organic compounds (VOCs), the vast majority of organic compounds that contaminate California's groundwater reserves. For example, most industrial solvents, a major source of organics contamination, are VOCs. In addition, most VOCs are toxic, and ingestion of many VOCs has been shown to cause cancer in animals and, in some cases, humans.²⁴ Although pesticides are generally organic compounds as well, the discussion of pesticides in this report is confined to the section below that addresses them specifically.

VOCs are so named because of their volatility, meaning that they vaporize or evaporate readily at normal room temperature. VOCs are found in a wide range of products, including gasolines, paint thinners, paints, and solvents used for a variety of processes from dry cleaning to metal degreasing. VOCs can enter the groundwater through point sources, such as leaking storage tanks, or through nonpoint sources such as rain or runoff that has picked up VOCs from the air or the streets.

Some well-known examples of VOCs include benzene, found in gasoline, dichloromethane (methylene chloride), used in industrial solvents, trichloroethylene, a multi-purpose degreaser used, for example, in the manufacture of circuit boards (and as a septic system cleaner), tetrachloroethylene (perchloroethylene), another multi-purpose solvent used most notably in the dry-cleaning industry, and chloroform (trichloromethane), produced when water containing dissolved organic matter is chlorinated, such as in pulp, paper, chemical, and pharmaceutical manufacturing.²⁵

Data on the Incidence of VOCs in Groundwater. In 1983, the California Legislature passed a bill requiring the Department of Health Services to conduct a broad survey of California's groundwater wells for the presence of organic chemicals.²⁶ The first phase of the survey involved testing the water from some 2,947 wells used by large public water systems (those with at least 200 service connections) and believed most likely to be contaminated.²⁷ Those wells represented more than half of all the wells used by all the large public water systems in the state at the time.

The results of the tests were published in 1986, in a paper entitled "Organic Chemical Contamination of Large Public Water Systems in California." The researchers reported having detected the presence of 33 different organic compounds. However, several of those compounds only occurred in a small number of wells; only the 20 most prevalent compounds appeared in more than five wells (see Table 5). Eighteen of those 20 compounds, or 90 percent, are VOCs.²⁸ The other two, atrazine and simazine, are quasi-volatile pesticides and are therefore discussed separately below.

Overall, more than 18 percent of the sampled wells "showed some degree of contamination, while 165 (5.6 percent) exceeded one or more of the state's 'action

TABLE 5**Organic Chemicals Detected in California Groundwater in the mid 1980s**

As required by legislation passed in 1983, the Department of Health Services (DHS) conducted a survey of organic compounds in California groundwater. This table (taken directly from the DHS survey) shows the compounds detected most frequently as of 1986.

Source: Organic Chemical Contamination of Large Public Water Systems in California, DHS (Apr. 1986), pp. iv.

Chemical	Number of contaminated wells	1986 action level micrograms/liter (µ/l)
Tetrachloroethylene	199	4.0
Trichloroethylene	188	5.0
Dibromochloropropane (A)	155	1.0
Chloroform	116	100.0* (MCL)
1,1-Dichloroethylene	63	0.2
1,1,1-Trichloroethane	63	200.0
Carbon Tetrachloride	38	5.0
Atrazine (A)	37	None established
1,2-Dichloroethylene	29	None established
Simazine (A)	26	None established
Bromodichloromethane	25	100.0* (MCL)
Dibromochloromethane	21	100.0* (MCL)
1,2-Dichloroethane	17	1.0
Bromoform	14	100.0* (MCL)
1,1-Dichloroethane	12	None established
Methylene Chloride	11	40.0
Toluene	10	100.0
Benzene	9	0.7
Trichlorotrifluoroethane	8	None established
Xylenes	6	620.0
1,2-Dichloropropane (A)	4	10.0
1,1,2-Trichloroethane	4	None established
Chlorobenzene	3	None established
Trichlorofluoromethane	3	None established
1,2-Dichlorobenzene	2	130.0**
1,3-Dichlorobenzene	2	130.0**
1,4-Dichlorobenzene	2	130.0**
Ethylbenzene	2	None established
C3-Alkyl Benzenes	1	None established
C4-Alkyl Benzenes	1	None established
1,1-Dibromo-2-chloro-2-fluorocyclopropane	1	None established
Dichlorodifluoromethane	1	None established
Vinyl chloride	1	2.0

(A) — chemical is used primarily for agricultural purposes.

(MCL) — maximum contaminant level.

* — MCL is for the sum of the four compounds.

** — action level is for the sum of the three compounds.

levels' or 'maximum contaminant levels'."²⁹ Because most of these compounds do not occur naturally—and because the ones that do occur naturally do so only rarely—their presence at any level in groundwater is generally a sign of some anthropogenic contaminating activity. Most of the contaminants detected, however, were found in a relatively small group of counties.³⁰ Only Fresno, Los Angeles, Riverside, and San Bernardino counties had ten or more drinking water systems with positive results, and only Fresno, Los Angeles, and San Bernardino had more than five wells exceeding an action level.³¹

The study was subsequently expanded to include both public and private large water systems.³² Those investigations revealed that, among the 7,100 wells that were then part of a large water system, 854 (more than 10 percent) were "known to be polluted by toxic organic chemicals, and 267 [had] chemical concentrations exceeding action levels."³³ By 1987, DHS had already identified another 150 polluted wells operated by *small* water purveyors (generally 5 to 199 service connections), and no one had checked the nearly one million private wells in the state, 80 percent of which were being used to supply domestic water.³⁴ Even today, private wells do not receive any regular testing.

These studies were never updated.³⁵ Instead, the Department of Health Services transitioned into its present role as manager of the data collected under the state's Safe Drinking Water Act. As explained above, those data cover a more varied set of parameters than simply organics, but only active drinking water wells are monitored. NRDC analyzed the data from a recent one-year period (October of 1999 to October of 2000) to see if organic compounds continued to be present in current drinking water wells. NRDC found more than 8,500 instances in which organic compounds were detected.³⁶ Again, while these findings do not necessarily indicate an exceedance of a human health standard, this finding is nevertheless significant because the compounds do not generally occur naturally. Any detection, therefore, is indicative of anthropogenic causes.

The locations of almost 8,000 of the samples where organics were detected are plotted in Figure 14.³⁷ Another 660 sampling points (some of which may overlap) are not plotted because coordinate data were not available for them. None of the sampling data covered the several thousand stand-by and inactive wells that are no longer monitored,³⁸ many specifically because of contamination, and they do not include any monitoring of any other groundwater basins that have not been used as supply sites. (See sidebar, "What Happens When Contaminants are Detected?")

Figure 14 shows a substantial number of drinking water wells around the San Francisco Bay Area, in the South Coast region, and throughout the Central Valley in which organic compounds were detected. In fact, in the South Coast area, VOCs from industrial sources have so severely contaminated the aquifer beneath the San Gabriel Valley—the primary source of drinking water for more than one million people—that in 1984, EPA placed four areas on its Superfund National Priorities List.

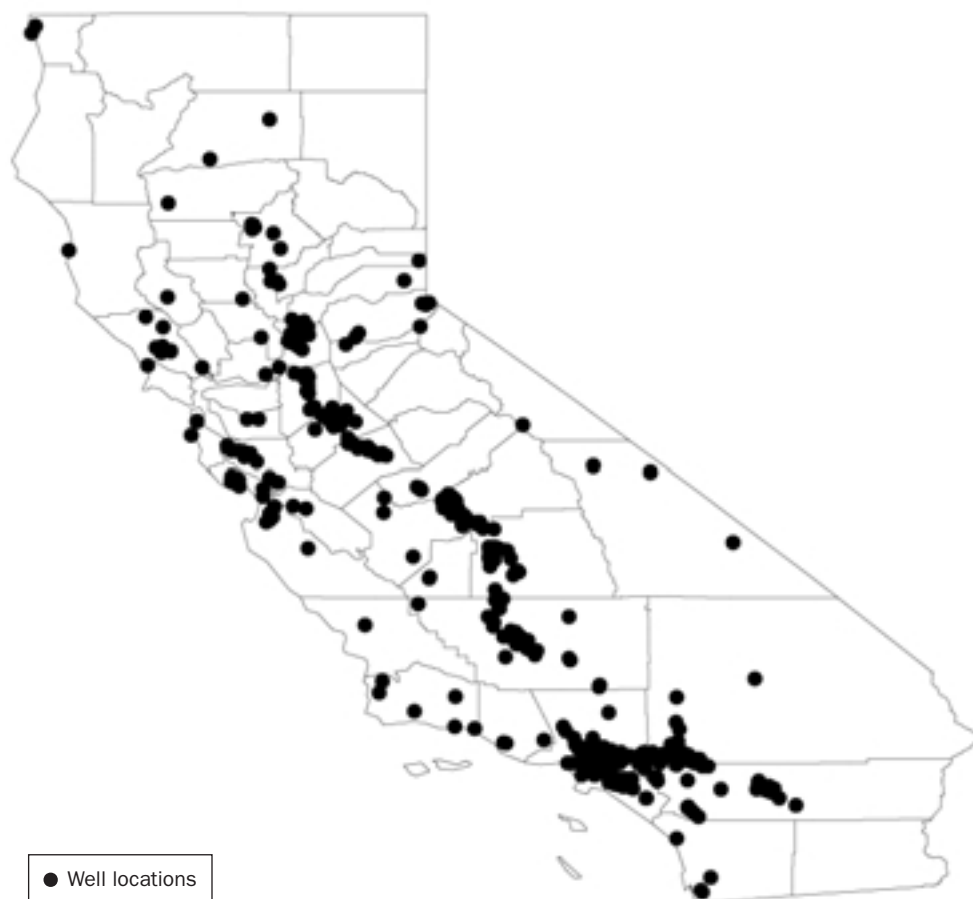
The only other potentially relevant information located by NRDC regarding organic contamination of groundwater was related to landfills. This information was considered potentially relevant because, as one Regional Water Board had noted,

Because most of these compounds do not occur naturally . . . their presence at any level in groundwater is generally a sign of some anthropogenic contaminating activity.

FIGURE 14**Organic Compound Detections in Drinking Water Sources**

The map displays locations of groundwater wells that were found to contain organic compounds, as reported to the Department of Health Services between October 1999 and October 2000.

Source: Data from the Department of Health Services (DHS) Drinking Water Database (October 1999–October 2000); compiled by LFR Levine-Fricke; mapped by NRDC.



“discharges of municipal solid wastes to unlined and single clay lined landfills have resulted in groundwater degradation and pollution by [VOCs] and other waste constituents . . . VOCs can easily migrate from landfills either in leachate or by vapor-phase transport. Clay liners and natural clay formations between discharges wastes and ground waters are largely ineffective in preventing water quality impacts.”³⁹ The 1990 landfill study, discussed more fully on page 59, determined that two-thirds of California landfills were emitting one or more toxic solvents,⁴⁰ of which most are VOCs.

CASE STUDIES: MTBE

Background. Methyl tertiary-butyl ether (MTBE) is a colorless liquid commonly manufactured by reacting methanol, made from natural gas, with isobutylene, made from butanes derived from petroleum.⁴¹ A gasoline additive used to increase

octane ratings and reduce air pollution, MTBE became the 4th highest produced organic chemical⁴² in the U.S. in 1988, rising from a ranking of 39th in 1970.⁴³ MTBE accounts for about 11 percent of California's gasoline by volume and can be found at levels of up to 15 percent.⁴⁴ Furthermore, California is the third largest gasoline consumer in the world, with more than 13.7 billion gallons of gasoline used per year.⁴⁵ Consequently, about 100,000 barrels of MTBE are consumed in California per day.⁴⁶

MTBE presents a significant threat to California's water resources. It is more water-soluble than typical gasoline constituents, more costly to remove from water, and has the ability to travel farther and faster once it comes in contact with a groundwater aquifer than do most other gasoline components.⁴⁷ These unfortunate physical and chemical characteristics have led researchers to conclude that "it is clear we are placing our limited water resources at risk by using MTBE."⁴⁸

Federal law requires gasoline refiners to add an oxygenate to California Phase II Reformulated Gasoline (Ca2RFG). MTBE was first used in gasoline in the United States in 1979 as an octane booster and a replacement for lead, but its use did not reach present levels until the Ca2RFG requirements took effect in June of 1996, and MTBE quickly became the oxygenate of choice among Californian refiners.⁴⁹ The U.S. Geological Survey's National Water Quality Assessment found MTBE in more than 20 percent of the wells surveyed in areas of the nation that use MTBE in gasoline.⁵⁰

The specific health impacts of MTBE are not yet fully understood. California's Office of Environmental Health Hazard Assessment concluded that it does not meet the state's definition of a carcinogen, but others have found the chemical to cause cancer in laboratory animals.⁵¹ In addition, a 1998 state auditor's report "called for tightening the regulatory process used to assess [sic] MTBE contamination and chastised [the Department of Health Services] for allegedly being slow in reporting MTBE contamination."⁵² The presence of MTBE in groundwater can also have significant aesthetic impacts, due to its turpentine-like smell and taste. MTBE has also been shown to pose a threat to kidney and liver health.⁵³

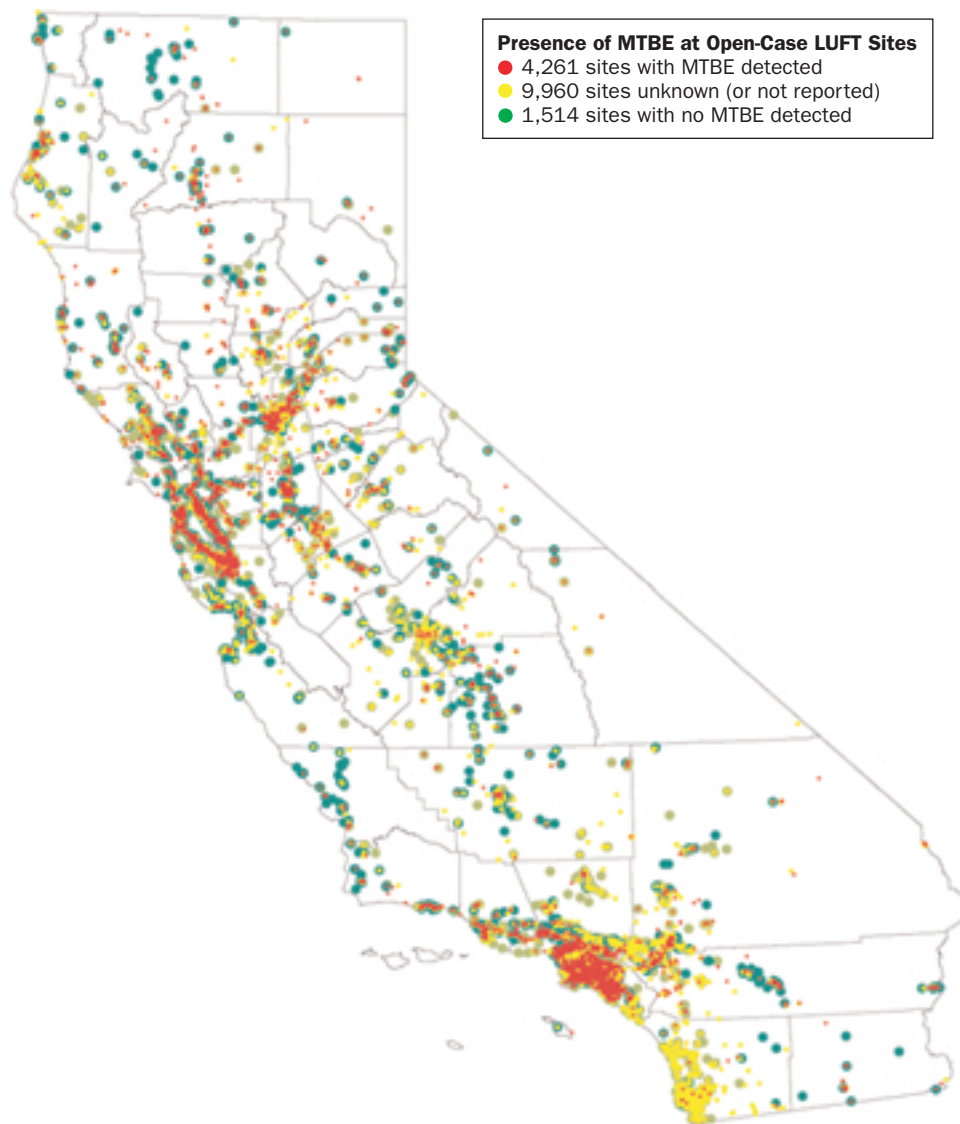
Because MTBE is found in gasoline and other petroleum fuels commonly stored in underground storage tanks, leaking underground storage tanks releasing MTBE-containing gasoline are likely the largest single source of the MTBE contamination in California's groundwater.⁵⁴ A small portion of the MTBE used (0.33%) is released into the atmosphere and is implicated as a non-point source of contaminants in shallow urban aquifers.⁵⁵ Other sources of MTBE pollution include runoff from streets and gas stations that picks up the spills and drips left behind from the refueling of automobiles; major spills, such as from automobile and tanker truck accidents; the discharge of unburned fuel from water craft (especially 2-stroke engines); lawnmowers, tractors and other machines; and leaks from pipelines and aboveground storage tanks.

In October 1997, Governor Gray Davis signed legislation directing the University of California to conduct research on the effects of the gasoline additive on health and the environment.⁵⁶ The University issued six grants to researchers from various

FIGURE 15**Leaking Underground Fuel Tank Sites in California**

Results of MTBE analysis (January 1999).

Source: "Methyl Tert Butyl Ether (MTBE) Impacts to California Groundwater," By Anne M. Happel and Brendan P. Dooher, Environmental Protection Department, Lawrence Livermore National Laboratory (March 25, 1999), UCRL-MI-133696.



campuses to conduct the research. In November of 1998, the report was delivered to the Governor and the Legislature. Among its findings were:

MTBE and other oxygenates were found to have no significant effect on exhaust emissions from advanced technology vehicles. . . . Thus, there is no significant additional air quality benefit to the use of oxygenates such as MTBE in reformulated gasoline, relative to alternative [Ca2FRG] non-oxygenated formulations.⁵⁷

Thus the UC researchers concluded that MTBE should be phased out completely. Four months later, on March 25, 1999, the governor issued an Executive Order

declaring that, "on balance, there is significant risk to the environment from using Methyl Tertiary-Butyl Ether (MTBE) in gasoline in California." Eleven tasks were then assigned to various state agencies responsible for carrying out the decree of the executive order, including the phase out of MTBE by 2003, reversal of Clean Air Act legislation necessitating MTBE use, extended funding and priority for MTBE cleanup, and the creation of an MTBE taskforce.⁵⁸

The Department of Health Services has set primary and secondary MCLs for MTBE of 13 and 5 micrograms per liter ($\mu\text{g/L}$), respectively.⁵⁹

Data on the Incidence of MTBE in Groundwater. MTBE has been detected in groundwater throughout California. It has forced water suppliers to shut down drinking water wells in Santa Monica, South Lake Tahoe, Santa Clara Valley and in the Sacramento area. Private wells in the city of Glennville have also been shut down.⁶⁰

The Lawrence Livermore National Laboratory recently concluded that MTBE is a "frequent and widespread contaminant" in groundwater throughout California and does not degrade significantly once it is there. The study estimated that MTBE has contaminated groundwater at more than 10,000 shallow monitoring sites in California. It also states that approximately 70 percent of the sites that were tested for MTBE showed detectable levels.⁶¹

In 1998, the state had identified almost 3,500 sites contaminated with MTBE due to leaking underground storage tanks alone.⁶² By 1999, the count was well above 4,000 (see Figure 15). At 3,000 of these sites, the contamination already exceeds the state MCLs, and more than 75 percent of *those* sites are in one of twelve counties, three of which are in Southern California (Los Angeles, Orange, and Riverside counties), and nine of which are in the Bay Area or Sacramento area (see Figure 16).⁶³

Furthermore, given the number of active underground storage tanks that had not been upgraded to meet the December 22, 1998 upgrade requirements as of August 1998, and assuming a two percent annual leak rate, the UC researchers estimated that, during the upgrade process, at least another 690 tanks would likely be found to have leaked.⁶⁴

As of January 2001, the Department of Health Services had received 40 reports of MTBE being detected in public water supply wells, and this number is expected to increase (see Table 6).⁶⁵ In fact, there had been only 37 reports just two and one half months earlier.⁶⁶ In 27 of the 40 samples where MTBE was detected, the concentration was above the secondary maximum contaminant level (the level set for taste, odor, and appearance), and in 16, the MTBE concentration was above the primary MCL, set to protect public health.⁶⁷

In some cases, these exceedances are more than an order of magnitude above the state standards of 5 $\mu\text{g/L}$ (secondary MCL) and 13 $\mu\text{g/L}$ (primary MCL). Although many of the exceedances are in the range of 10 to 30 $\mu\text{g/L}$, samples taken in El Dorado, Kern, and Orange Counties were in the range of 40 to 100 $\mu\text{g/L}$. Moreover, samples in Yuba County have exceeded 200 $\mu\text{g/L}$, and in Los Angeles and San Francisco, numbers have been seen close to, or even exceeding, 500 $\mu\text{g/L}$.⁶⁸

In the one year of data NRDC analyzed from the Department of Health Services' Drinking Water Database, even though wells in many areas had already been shut

In 1998, the state had identified almost 3,500 sites contaminated with MTBE due to leaking underground storage tanks alone. By 1999 the count was well above 4,000.

FIGURE 16**MTBE: The Dirty Dozen**

Twelve counties—Alameda, Contra Costa, Los Angeles, Orange, Placer, Riverside, Sacramento, San Francisco, San Joaquin, San Mateo, Santa Clara, and Solano—account for 75 percent of all recorded MTBE detections above the Maximum Contaminant Levels in California.

Source: Data from “Uncontrolled LUSTs,” Environmental Working Group (July 2000) Table 8, p. 21; mapped by NRDC.



down due to MTBE contamination, MTBE was detected above the MCLs in active sources of drinking water in nine additional areas. In the Bakersfield area, MTBE was found in five separate sites in excess of the MCL, and the average concentration of those sites was over 17 µg/L.⁶⁹

CASE STUDY

The salience of MTBE contamination as a threat to California’s water resources is perhaps most dramatically displayed by the situation in Santa Monica. In 1997, the City of Santa Monica was forced to close half of its drinking water wells upon discovering that they contained MTBE at levels exceeding recommended safety levels.⁷⁰ MTBE was found in the city’s wellfield at levels ranging from about 50 µg/L to 610 µg/L. The city has lost about 80 percent of its water supply due to MTBE contamination and must purchase replacement water at a cost of about \$3.25 million per year.⁷¹

TABLE 6**Reported MTBE Detections in Drinking Water Sources (as of January 3, 2001)^{a,b}**

This table, compiled by the Department of Health Services, indicates the number of MTBE detections above the primary maximum contaminant level (MCL) of .013 mg/L and the secondary MCL of .005 mg/L in drinking water sources that were active as of January 3, 2001.

Source: California Department of Health Services, <http://dhs.ca.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm>.

Systems and sources	Number sampled	MTBE detections	MTBE conc. >0.005mg/L	MTBE conc. >0.013mg/L
Groundwater sources	7,253	40 (0.6%)	27 (0.4%)	16 (0.2%)
Surface water sources	511	24 (4.7%)	8 (1.6%)	2 (0.4%)
Total sources	7,764	62 (0.8%)	35 (0.5%)	18 (0.2%)
Public water systems ^c	1,901	37 (1.9%)	22 (1.2%)	13 (0.7%)

^a MTBE is considered "detected" if present in at least two samples from a source.

^b The *detection limit for purposes of reporting* (DLR)—the level at which DHS is confident about the quantification of the chemical's presence—is 0.003 mg/L for MTBE.

^c The 1,901 systems collectively serve about 30.1 million of the state's 34 million people.

Another severe MTBE situation affects South Lake Tahoe, where 12 of the South Tahoe Public Utility District's 34 wells have been shut down due to the threat of MTBE contamination from nearby leaking underground storage tanks. Eight of those wells have already been contaminated, with the highest level of contamination at 37 µg/L.⁷²

Nitrates

Nitrogen-based compounds are the most problematic type of nutrient contamination in California. The Department of Water Resources has stated that three-fourths of the impaired groundwater in California was contaminated by salinity, pesticides, and nitrates, primarily from agricultural practices.⁷³ Salinity was addressed in the first section of this chapter, and pesticides are addressed in the following section. This section addresses nitrates.

Background. The two primary sources of nitrate contamination are agriculture and septic systems.

Agriculture can contribute to nitrogen contamination in multiple ways. Both commercial fertilizers and other forms of animal waste contain high levels of nitrates. Although the former are used to stimulate plant growth and the latter is regarded as a waste product to be disposed of, in agricultural settings the two generally reach the same resting place: they end up directly on the ground surface, allowing the nitrates to leach into the soil and down to the water table. Thus, two of the primary ways in which agriculture contributes to nitrogen contamination are (1) through the direct application of commercial fertilizers and (2) through the generation, and improper disposal, of the vast quantities of animal waste associated with concentrated animal feeding operations (CAFOs), also known as "factory farms."⁷⁴

Some nitrogen is absorbed by plants as part of the natural growth process, but massive agricultural operations often use (in the case of crop production) and generate (in the case of livestock operations) more nitrogen than the resident flora can assimilate

through the natural cycle.⁷⁵ Dairies, in particular, tend to produce huge quantities of nitrogenous wastes due to the high concentration of cows. One dairy cow is estimated to produce about 144 pounds of nitrogen waste per year.⁷⁶ Operations with 7,000 or more animal units generate a volume of manure equivalent to a city of 45,000 people.⁷⁷

Septic systems are the other significant cause of nitrate contamination. In many places, especially those experiencing rapid urbanization (such as Ventura County or northern Los Angeles County), nitrogen reaches groundwater through poorly designed or constructed systems and/or unsuitable site conditions.⁷⁸

Nitrate is of concern for two main reasons. First, certain crops may be affected by nitrate concentrations as low as 5 milligrams per liter.⁷⁹ Second, though perhaps more significantly, ingestion of nitrate can be harmful to infants and young children. Immature human digestive systems will convert the nitrate into nitrite, which then enters the bloodstream, binds with hemoglobin, and reduces the blood's ability to carry oxygen. This can lead to the potentially fatal "blue baby syndrome."⁸⁰ The state drinking water limit of 10 milligrams of "Nitrate + Nitrite (sum as nitrogen)" per liter of water is set to protect against this.⁸¹

As a result of factory farming, the use of chemical fertilizers, and septic systems, nitrate contamination of groundwater in California is widespread.

Data on the Incidence of Nitrates in Groundwater. As a result of factory farming, the use of chemical fertilizers, and septic systems, nitrate contamination of groundwater in California is widespread. By 1994, nitrate levels more than double the acceptable limit resulted in the closures of more than 800 wells in Southern California and 130 in the San Joaquin Valley alone.⁸² Although they have not posed as significant a problem in other areas, nitrates are also among the primary pollutants in public water supply wells in the San Gabriel and San Fernando Valley Basins.⁸³ Wells in the San Martin area, along the Central coast, also exceed the nitrate objective.⁸⁴ And fertilizers and sewage spills have contributed to high nitrate levels in groundwater that percolates into Lake Tahoe.⁸⁵ All told, nitrates have caused the closure of more public wells than any other contaminant.⁸⁶

A 1983 study by the U.S. Geological Survey (USGS) found nitrate levels in excess of the 10 milligrams per liter standard in three areas of the Sacramento Valley.⁸⁷ Although the study noted that most of the contamination was in shallow aquifers, implying that wells could be drilled deep enough to bypass the contaminated sections, nitrates are highly mobile and are not likely to remain restricted to one area of the aquifer for long. Even confining layers, which may slow the migration of nitrates, will not prevent their movement completely.⁸⁸ This point was driven home recently when MTBE was found having made its way from shallow groundwater to a deep aquifer in Orange County.⁸⁹ Furthermore, if pumpers are forced to drill deeper wells to avoid the accumulation of nitrates, they may encounter other problems. For example, as noted above, the deeper the well in the Central Valley, the greater concentration of dissolved solids one is likely to encounter.⁹⁰

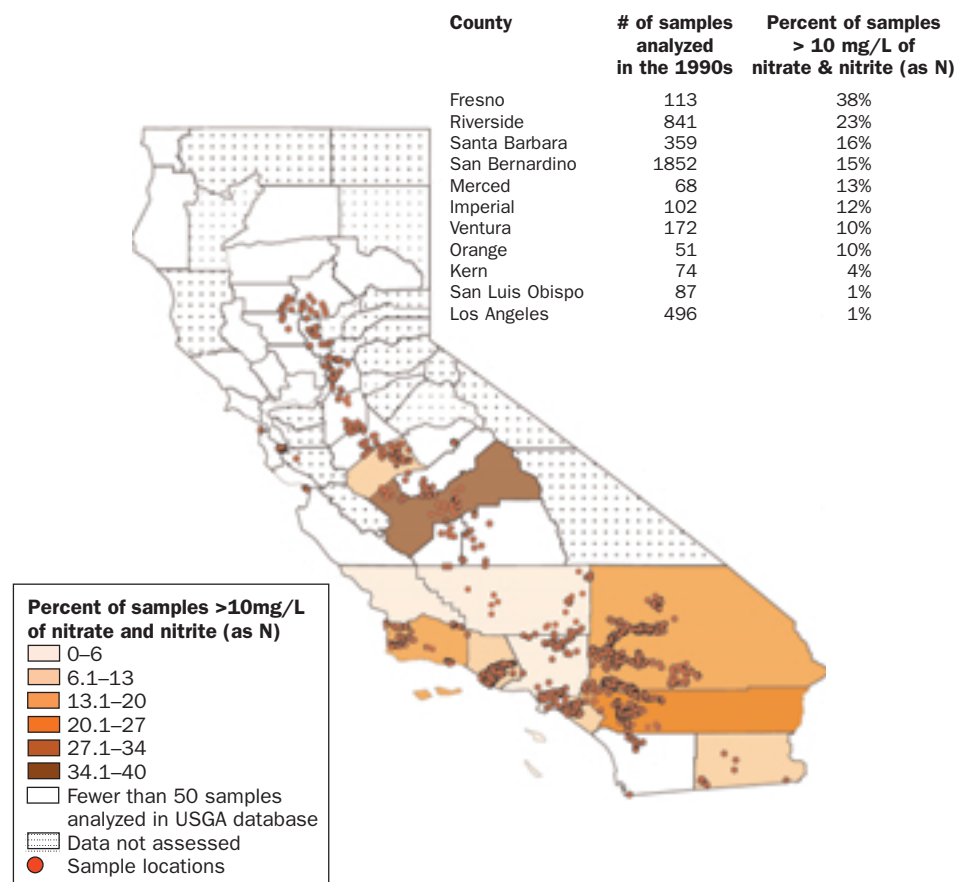
CASE STUDIES: SAN BERNARDINO COUNTY AND SAN JOAQUIN VALLEY

The map in Figure 17 reflects the levels of nitrate and nitrite (as nitrogen) in the groundwater in several California counties, based on the U.S. Geological Survey

FIGURE 17**Nitrogen in California Groundwater**

The state and federal maximum allowable concentration limit for nitrate plus nitrite (measured as nitrogen) in drinking water is 10 mg/L. NRDC reviewed 10 years of groundwater quality data (1990 to 2000) from the U.S. Geological Survey (USGS) for 38 of California's 58 counties and calculated the number of samples that exceeded that threshold. For any county in which USGS analyzed more than 50 samples over that 10 year period, this map shows the percent of those samples that exceeded the 10 mg/L limit. The USGS did not sample randomly throughout the state, and the samples were not designed to be representative of entire counties. However, it is the most comprehensive data available.

Source: Data from U.S. Geological Survey (1990–2000); compiled by NRDC.



(USGS) data for the period 1990–2000.⁹¹ As with salinity, only counties for which there were a significant amount of data are represented in Figure 17. The others are either blank (if there were insufficient data)⁹² or spotted (if data were not requested for those counties). The shading indicates the percentage of those samples that exceeded the 10 milligram per liter MCL for nitrate plus nitrite (as nitrogen). The divisions in this map were created electronically, based on natural breaking points.⁹³

The data show substantial numbers of samples in which nitrogen was above the MCL throughout the Central Valley and in the non-coastal areas of Southern California. This is consistent with other reports that nitrates are especially problematic in the San Joaquin and Salinas Valleys, and in the Chino Basin of Southern California.⁹⁴ The San Joaquin Valley and Chino Basin are discussed below.

San Bernardino County and the Chino Basin. Total nitrogen increased consistently throughout the 20th century in many areas. The Middle Chino Sub-basin is a good example of one such area. The area began shifting from crop production to dairy farming in the 1940s, and, by 1971, despite the semi-annual cleaning of dairy corrals, it was estimated that 720 pounds of nitrogen per acre were left on the land from wastes.⁹⁵ That is four times the amount of nitrogen added to each acre for crop production in 1969, seven times the amount used in 1950, and about 20 times the amount used prior to 1930.⁹⁶

The map in Figure 18 reflects nitrogen levels from sampling points collected by USGS throughout San Bernardino County in the 1990s.⁹⁷ Again, given an MCL of 10 mg/L, Figure 18 shows that the problem is not limited to the Chino Basin. The area around Yucaipa, at the base of the San Bernardino Mountains, also reported nitrogen levels well above this threshold. Crossing over the mountains into the Southern California High Desert, high levels of nitrates continue to appear around Apple Valley and Hesperia (in the West), near Twentynine Palms, and in the North, near Barstow.

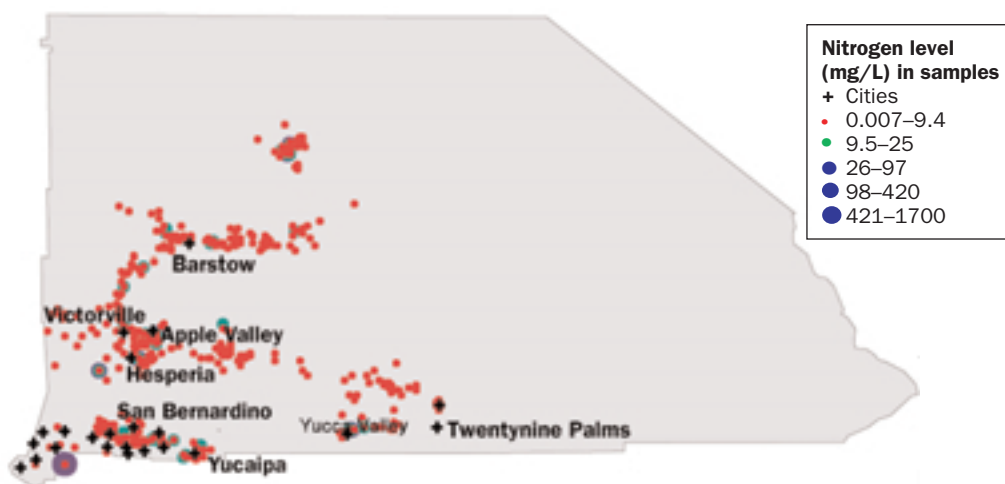
San Joaquin Valley. From 1993 to 1995, USGS found nitrate concentrations exceeding the drinking water standard in 24 percent of the domestic wells sampled in the Eastern San Joaquin Valley. It also found that the median nitrate concentrations had

FIGURE 18

Nitrogen in San Bernardino County Groundwater

Based on the information portrayed in Figure 17, NRDC chose San Bernardino County as an example of a county with significant nitrogen impairment of its groundwater. This map shows the approximate level of nitrate plus nitrite (expressed as nitrogen) in every groundwater sample taken between 1990 and 2000 for which the U.S. Geological Survey has data. The maximum concentration for drinking water is 10 mg/L. The divisions on this map were created using "natural breaks" (see endnote 93), and a natural break occurred very close to the 10 mg/L limit. The samples represented by the red dots on this map are significantly below that threshold. The samples represented by the green dots exceed the threshold by as much as two and one half times. The blue dots represent the locations of samples that even further exceed the threshold.

Source: Data from U.S. Geological Survey, (1990–2000); compiled by NRDC.



ATRAZINE

Atrazine is a good example of a common pesticide with significant health implications. In 1989, the Department of Health Services set a maximum contaminant level of 3 ppb for atrazine, listed it as an endocrine disrupter, and left it on the Department's priority list due to its possible carcinogenic status as well. Subsequently, a four-year study by the National Academy of Sciences found that elevated levels of atrazine were "associated with excess rates of cardiovascular, urogenital, and limb reduction deficits."¹⁰⁴ Nonetheless, atrazine was still widely used. In 1997, 46,000 pounds of atrazine were applied as weed killer on fodder crops to feed cattle and corn.¹⁰⁵

increased, corresponding with the increase in fertilizer use, both from the 1950s to the 1960s and from the 1970s to the 1980s.⁹⁸

Pesticides

In 1999, there were more than 600 pesticides in use in California,⁹⁹ many of which are now making their way into California's groundwater.¹⁰⁰ This figure does not include any pesticides that have been banned: some of these continue to leach into the groundwater at toxic levels long after they have been taken out of legal use.¹⁰¹ The U.S. Geological Survey recently concluded that "the primary criterion for whether pesticides had been detected in the groundwater in a state appears to be whether or not [researchers] have looked [for them]."¹⁰²

Background on Health Impacts. Pesticide contamination is a serious public health concern, as ingestion of pesticides can cause a wide range of serious illnesses, including, in the case of many pesticides, cancer. Furthermore, most of the agricultural land to which pesticides are applied in California lies directly over extensive groundwater reserves that are used as a predominant source of drinking water for rural communities.¹⁰³

The Department of Health Services assigns maximum contaminant levels (MCLs) for pesticides, as it does for other water pollutants, to protect the public health. However, despite the fact that California uses hundreds of pesticides, the Department has assigned MCLs to only 27 of them (see Glossary—Human Health-Based Water Quality Standards).

In addition, the MCLs that have been set may not be stringent enough. MCLs are based, in part, on public health goals (PHGs) developed by the California Office of Environmental Health Hazard Assessment. However, the Department of Health Services has set the MCLs for ten pesticides at levels higher than their PHGs. Seven of these ten pesticides have been detected at levels between their PHGs and their MCLs, including the infamous atrazine and dibromochloropropane (DBCP).

Data on the Incidence of Pesticides in Groundwater. Of the 27 pesticides for which the Department of Health Services has established MCLs, 16 have been detected at levels

FIGURE 19
Counties with Significant Pesticide Detections

Source: Data from Department of Pesticide Regulation; compiled by NRDC.



exceeding their MCLs, but no follow-up testing has occurred.¹⁰⁶ In addition to the various local water agencies that test drinking water sources under the Safe Drinking Water Act and the sporadic testing performed by the U.S. Geological Survey, the California Department of Pesticide Regulation (DPR) is dedicated specifically to the study and control of pesticides. DPR monitors both the presence of pesticides in the groundwater and the extent of pesticide use, on a regular basis, throughout California.

Existing Contamination. California's DPR is required to conduct ongoing groundwater monitoring for certain legal pesticides and to report annually on the results of its tests.¹⁰⁷ The most recent report available on DPR's website, as of February 1, 2001, covers the period from July 1998 through June 1999. It lists the results of 61,931 samples from 2,389 wells in 49 of California's 58 counties. These samples were tested for 111 "pesticide active ingredients and breakdown products."¹⁰⁸

Although the report explicitly notes that it is neither a complete survey of groundwater basins in the state, nor does it cover all pesticides,¹⁰⁹ it nevertheless revealed the widespread presence of pesticides in the groundwater. For example, there were eight separate counties in which DPR found at least one of the pesticides for which it tested in at least ten percent of the wells it surveyed (see Figure 19).¹¹⁰ In all, 17 compounds

were detected—four at levels above their MCLs (three of which were above U.S. EPA MCLs as well), and ten of which had no MCL, so that the extent of the danger posed is unknown.¹¹¹

It is clear that many pesticides have made their ways to California's groundwater basins in significant quantities, and several have had a relatively widespread impact. For example, since 1990, at least 18 different pesticides have been detected at ten or more different sites in California groundwater wells.¹¹² Also, in close to half of the counties in California (26 out of 58), pesticides in general have been detected in more than ten different sites.¹¹³

Many more pesticides were detected less frequently or less pervasively but nonetheless still had significant impacts. The basins to which the pesticides have traveled are often significant basins for human groundwater use. Thus, in the 1990s, pesticides were detected in the principal water sources of suppliers serving 16.5 million people, in 46 of 58 California counties.¹¹⁴

NRDC surveyed the Department of Health Services' Drinking Water Database for the pesticide DBCP. DBCP is a good example of a pesticide whose public health goal is well below its MCL. In the one year of data from October 1, 1999 through September 30, 2000, there were fewer than 600 sites in the Department's database where DBCP was detected above the MCL; however, there were more than 1,600 sites where it exceeded the applicable public health goal. Both sets of sites are displayed in Figure 20.

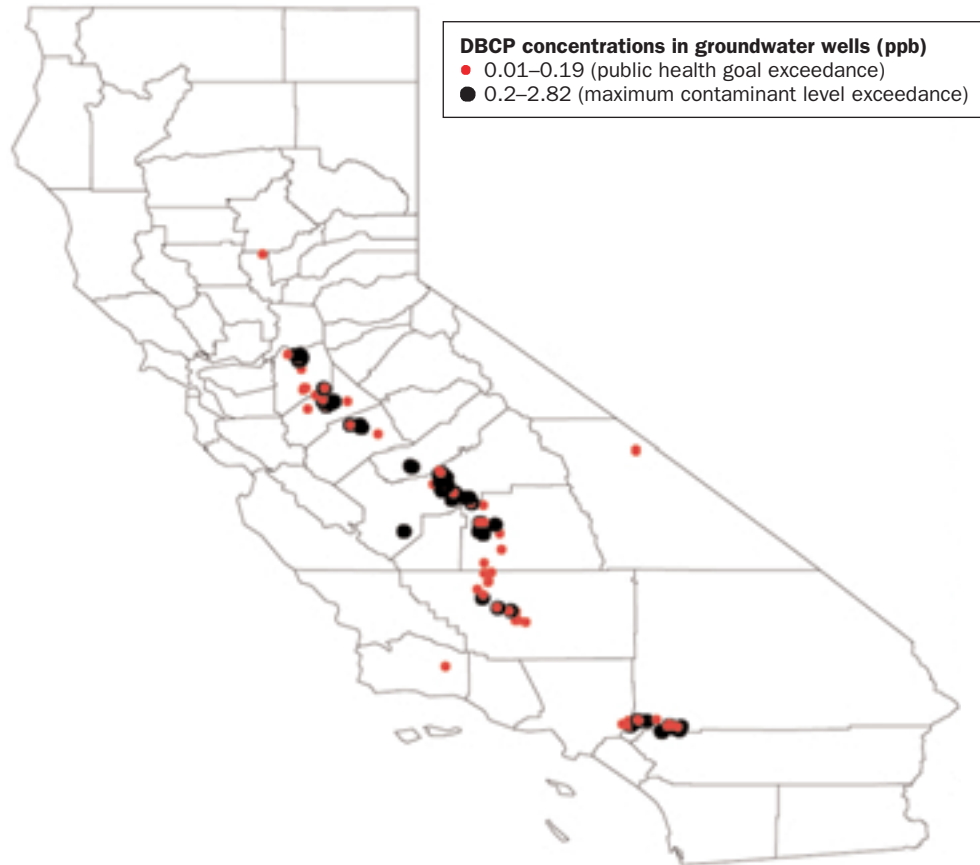
Finally, although pesticide use is most common and most problematic in agricultural areas, pesticides have also been detected in groundwater below golf courses, commercial and residential areas, rights-of-way, timber production and processing areas, and public gardens.¹¹⁵ Although there is little information on the presence of pesticides beneath non-agricultural lands, application rates in these areas often exceed those for most crops, indicating that these areas may have even higher levels of pesticides in their groundwater than the agricultural areas that have been the focus of study.¹¹⁶

Pesticide Use. In 1999, pesticide users reported applying more than 200 million pounds of pesticides. That figure represents a slight decrease from 1998, but, due to the annual fluctuations, any meaningful comparison must compare use levels over multiple years.¹¹⁷ In 1999, usage was within 1.2 percent of the five-year average from 1995–99, and that five-year average was up over 16 percent from the previous five-year average.¹¹⁸ Thus, the reality is that pesticide use in the latter part of the 1990s was up, and remained so through the end of the decade. Looking at the data geographically, of the ten counties using the greatest amounts of pesticides, the top four were all in the San Joaquin Valley, and seven of the ten were in the Central Valley, joined by Monterey, Imperial, and Ventura counties in positions 5, 7, and 10, respectively.¹¹⁹

In addition to the overall quantity of pesticides used, it is important (perhaps more important) to look at which pesticides are being used. The general trend in pesticide use since the 1960s has been to shift away from the use of the more persistent organochlorides (such as D.D.T.) in favor of organophosphates and carbamates, which are less persistent but highly soluble and mobile—as well as more acutely toxic.¹²⁰ DPR reports a recent decrease in the use of organophosphate and carbamate chemicals, as well, but it is not clear from available DPR data whether the change is significant.¹²¹

FIGURE 20
The Pesticide DBCP in Drinking Water Sources

Source: Data from the Department of Health Services (DHS) Drinking Water Database (October 1999–October 2000); compiled by LFR Levine-Fricke; mapped by NRDC.



In addition, another recent DPR report analyzed which active ingredients increased the most (and which decreased the most) from 1991 to 1997¹²² and found the following six to have the largest absolute increase in pounds used: sulfur, metam-sodium, oils, methyl bromide, copper sulfate (pentahydrate), and chlorpyrifos.¹²³ Three of these (metam-sodium, methyl bromide, and chlorpyrifos) are powerful neurotoxins, which therefore raise significant human health concerns,¹²⁴ and copper sulfate is very toxic to fish and can be corrosive to the skin and eyes.¹²⁵ (In addition, sulfur, although not a major source of concern for groundwater contamination, is a powerful irritant and thus of great concern to the farm worker community.) Perhaps most significantly, 1999 use of reproductive toxins was up more than 10 percent from the nine-year average, and use of carcinogens increased by more than 30 percent.¹²⁶

CASE STUDY: THE CENTRAL VALLEY

Agricultural use of pesticides is widespread in California's Central Valley,¹²⁷ and, as a result, pesticide contamination is at its worst in the Central Valley.¹²⁸ By 1984, at least 50 pesticides had been detected in the Valley's groundwater.¹²⁹ A 1993–95 study

by the U.S. Geological Survey found pesticides in 69 percent of the domestic wells sampled in the Eastern San Joaquin Valley. However, it did not find any evidence that pesticide concentrations had increased in the period from 1986–7 to 1995.¹³⁰

The remainder of this section focuses on the incidence of one particular pesticide, 1,2-dibromo-3-chloropropane (DBCP). A potentially carcinogenic nematocide and one of the most potent testicular toxicants known (having caused permanent sterility in many exposed workers),¹³¹ DBCP has been detected in the groundwater in every county in the San Joaquin Valley.¹³² Because it was outlawed in August of 1977,¹³³ the Department of Pesticide Regulation no longer tests for it in its annual surveys. However, DBCP has proved extremely persistent in groundwater.¹³⁴ In 1985, eight years after it was banned, it was still present in high enough concentrations to force the closure of about 1,400 wells in the Central Valley.¹³⁵ In 1989, when the Department of Health Services set the MCL at a level lower than the previously existing action level,¹³⁶ DBCP levels were still high enough that the setting of the MCL triggered the treatment or closure of more than 2,900 additional wells.¹³⁷ Moreover, the Department's new, lower MCL turned out to be more than 100 times higher than the public health goal set by the Office of Environmental Health Hazard Assessment in 1999.¹³⁸

The U.S. Geological Survey study mentioned above found concentrations still exceeding EPA drinking water standards in 20 percent of the domestic wells sampled in the Eastern San Joaquin Valley between 1993 and 1995.¹³⁹

Perhaps the area hit hardest by DBCP contamination is the Fresno area. In the 1980s, 44 wells were shut down in Fresno because of DBCP contamination. This was the first case of severe and widespread pesticide contamination in a major city. Because the City of Fresno got all of its water from the ground, the problem was particularly severe, as the city had to locate new sources of water quickly. In the 1990s, DBCP was detected in the city's water supply 423 times at levels above the MCL, which, as indicated above, is substantially higher than the public health goal for the pesticide.¹⁴⁰

Again, Figure 20 shows the locations where DBCP was detected in sources of drinking water during the one year from October 1999 to October 2000. The larger points are instances where samples not only exceeded the Office of Environmental Health Hazard Assessment's public health goal, but also the Department of Health Services' MCL. Fresno County (including the Fresno, Clovis, and Parlier areas) had by far the largest number of detections. Some other heavily impacted areas include the areas around Lodi and Modesto (in San Joaquin and Stanislaus counties, respectively), and the areas around Rancho Cucamonga in San Bernardino and Riverside counties. Kern, Tulare, and Merced counties also had substantial instances. In all, there were 1,623 sites in which the level of DBCP exceeded the public health goal during that one year. This does not count wells that were not tested because they had been taken out of service due to contamination, nor wells that are not used as drinking water sources.

Metals

Metals occur naturally in soil and groundwater, but human activity can substantially alter these concentrations, resulting in greater human exposure. Two of the metals of

the greatest concern in California drinking water are mercury and arsenic.¹⁴¹ Mercury, which tends to be more of a problem in surface water, is primarily a remnant of mining operations that released mercury from rocks or used it to extract gold from ores.¹⁴² Thus, mercury is discussed below, in the section on mining.

Arsenic is also a naturally-occurring metal, but its presence in groundwater results from a combination of natural and anthropogenic sources. Naturally-occurring arsenic “can be chemically mobilized and subsequently migrate into groundwater at landfills and other sites where contaminants such as VOCs and petroleum products are present.”¹⁴³ The discussion below focuses on arsenic. There is also a separate section on chromium, due to the recent attention focused on hexavalent chromium in California groundwater.

Arsenic. Background. Arsenic is a known toxin and carcinogen. In February of 2000, NRDC released a report showing that millions of Americans drink tap water from systems with average arsenic levels that pose unacceptably high risks of cancer.¹⁴⁴

Until recently, the state and federal MCLs for arsenic were 50 parts per billion (ppb).¹⁴⁵ Based on standard risk assessment methods, that level of arsenic may translate to a cancer risk for people consuming the water as high as *one in one hundred*.¹⁴⁶ Due in part to pressure from NRDC, in September 2000, the U.S. Environmental Protection Agency (EPA) proposed reducing the MCL for arsenic to 5 ppb. Even this level represents a cancer risk far higher than EPA normally allows in tap water. A level of 0.5 ppb would present the highest cancer risk that EPA would traditionally allow in tap water.¹⁴⁷ On January 22, 2001, EPA published the new MCL at 10 ppb, but, notwithstanding the compromises represented in even this standard, the Bush Administration recently announced that it intends to reassess it.

The consulting firm Saracino-Kirby recently completed a report for the Association of California Water Agencies on arsenic concentrations in California groundwater, based on an extensive composite database developed from a variety of sources.¹⁴⁸ It found the average concentration of arsenic in California groundwater to be 9.8 ppb, almost twice as high as EPA’s original proposal for the new MCL and far higher than would normally be acceptable. Over the ten-year period from 1990 to the present, fully 45 percent of the individual sampling locations in the database, and 72 percent of the groundwater basins in the state, had average concentrations of 5.0 ppb or higher.¹⁴⁹ Figure 21 is taken from the study and shows average levels of arsenic in counties throughout California.

NRDC also checked the Department of Health Service’s Drinking Water Database for the period from October 1999 to October 2000. There were almost 1,200 samples during that one-year period that exceeded 0.5 ppb. About 485 samples exceeded 5 ppb, and almost 300 exceeded 10 ppb.

CASE STUDIES

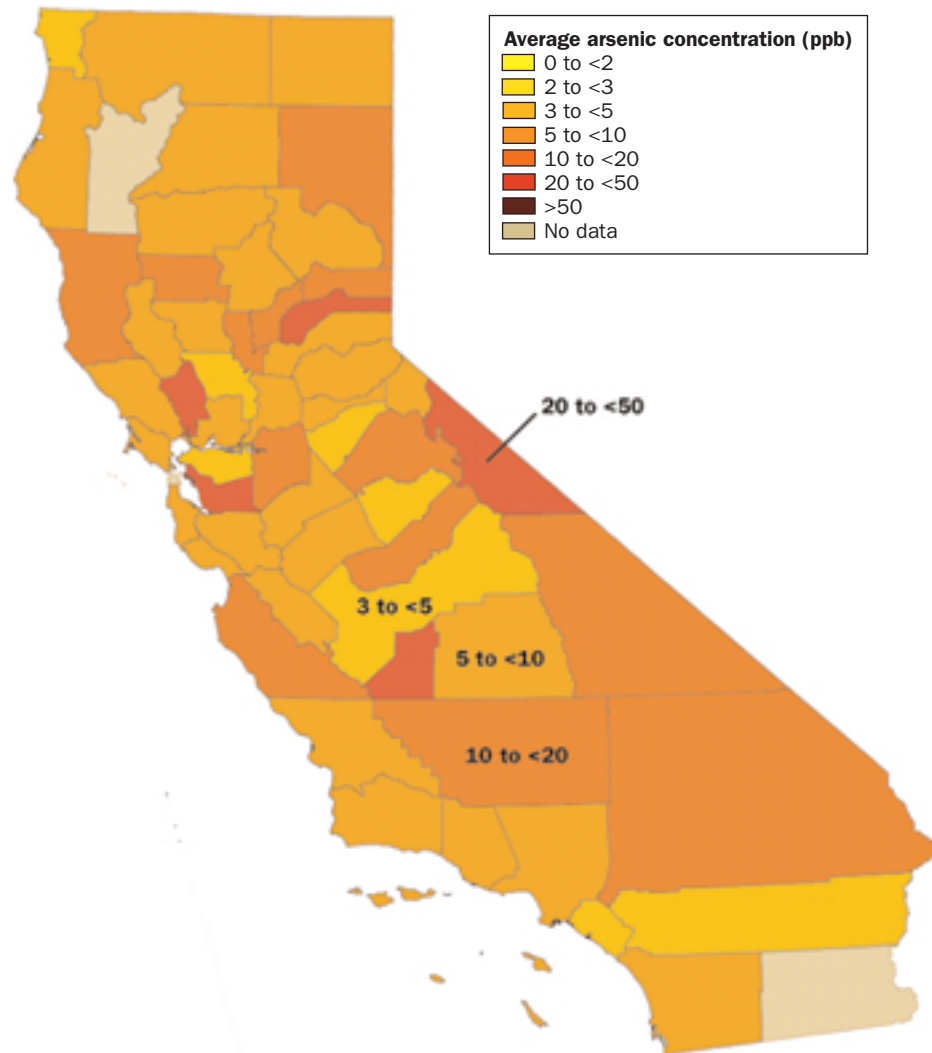
There are several groundwater basins with very high concentrations of arsenic around the corridor of Interstate 80, from the Bay Area through the Sacramento area and into Lake Tahoe. The Saracino-Kirby study indicates that Alameda, Napa,

FIGURE 21

Average Arsenic Concentrations in Groundwater by County (1990–2000)

Until recently, both the state and federal arsenic drinking water standards were set at 50 parts per billion (ppb). However, because that level of arsenic may create a cancer risk as high one in 100, the U.S. Environmental Protection Agency (EPA) undertook an extensive review of that standard and (in 2000) proposed that it be lowered to 5 ppb—a level that still produces a higher cancer risk than EPA normally allows in tap water. In January 2001, EPA finalized its new rule, setting the standard at 10 ppb. In March 2001, the Bush administration rescinded that action. This map shows average concentrations in each county, based on samples collected by various agencies and compiled and analyzed by the consulting firm Saracino-Kirby.

Source: Arsenic Occurrence and Conjunctive Management in California, Saracino-Kirby, Inc. (Sept. 2000).



and Nevada counties have particularly high levels of arsenic, each with county averages of more than 20 ppb, which, according to standard risk assessment methods, translates to about a one in 250 cancer risk.¹⁵⁰ Similarly, parts of Santa Clara, Sonoma, Sutter, and Yuba counties, and a wide stretch along the west side of the San Joaquin Valley, all the way down to the entire western half of Kern County, have average levels above 10 ppb.¹⁵¹ Five to 10 ppb translates approximately to a one in 1,000 cancer risk.¹⁵²

Similar numbers are evident in the Drinking Water Database. High arsenic levels exist all across Kern County (for example in Kern, Boron, Edison, and Arvin); in the City of Truckee, in Nevada County; and in Yuba City, in Yuba County. The drinking water sites also show a concentration of high levels around the Los Angeles/Orange/San Bernardino county confluence, throughout San Bernardino county, in Riverside county, and, again, in Sonoma county. This is consistent with the data collected by NRDC several years ago, which showed the highest levels at the tap in Whittier, Lancaster, and Los Angeles Department of Water and Power water.¹⁵³

Hexavalent Chromium. *Background.* Chromium is another metal that occurs naturally in the environment, and at least one form of chromium is a necessary part of the human diet: The human body needs trivalent chromium to process sugar.¹⁵⁴ Hexavalent chromium, however (also known as chromium 6), is a highly toxic,¹⁵⁵ potentially corrosive, “oxidized”¹⁵⁶ form of chromium, the primary source of which is industrial operations such as metal-plating, paint production, and cooling tower water.¹⁵⁷ It has a powerful irritant effect and is a known carcinogen when inhaled.¹⁵⁸ It is also suspected of being a carcinogen when ingested orally, though there is some dispute as to whether that is true and at what levels.¹⁵⁹

*The California
Department of Health
Services does not
regulate chromium 6
directly.*

The California Department of Health Services does not regulate chromium 6 directly. It has used an MCL of 50 micrograms per liter ($\mu\text{g}/\text{L}$) for *total* chromium since 1977,¹⁶⁰ but it has never set a standard specifically for chromium 6. In 1998, California’s Office of Environmental Health Hazard Assessment set a public health goal (PHG) for chromium 6 of 0.2 $\mu\text{g}/\text{L}$. Assuming that chromium 6 represents between 6 and 7.2 percent of total chromium, the agency then revised its suggested PHG for total chromium to 2.5 $\mu\text{g}/\text{L}$.¹⁶¹

On March 15, 1999, the Department of Health Services announced its intention to review its MCL for total chromium, based on these new PHGs.¹⁶² However, five months later, the *Los Angeles Times* reported that health officials estimated it would take as much as five more years to implement the recommendation. In response, the California legislature and the Los Angeles County Board of Supervisors began instituting additional tests and pressuring the Department of Health Services to act more quickly.¹⁶³ At the end of September, Governor Davis signed a bill requiring the Department to assess the threat and report to him and the Legislature by January 2002.¹⁶⁴

According to published reports on the results of the Los Angeles County studies, total chromium levels in county facilities’ tap water ranged from 0 to 8 $\mu\text{g}/\text{L}$, often well above the newly established PHG of 2.5.¹⁶⁵

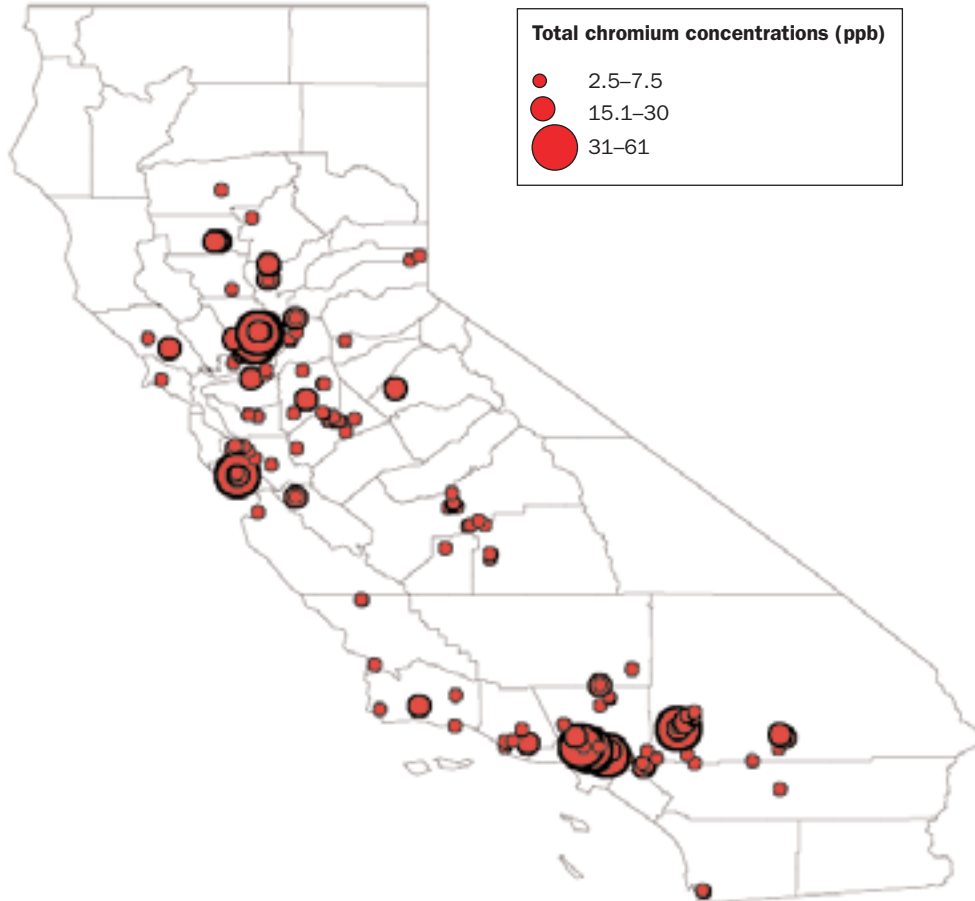
Of even greater concern, though, the Los Angeles County study found chromium 6 making up much more of the total chromium than had been previously assumed. The 2.5 PHG for total chromium was created as a proxy for a chromium 6 PHG of 0.2 $\mu\text{g}/\text{L}$, on the assumption that chromium 6 made up no more than 7.2 percent of total chromium. The August 20 article showed chromium 6 making up 64–91 percent of total chromium in four wells, and 99 percent in a fifth.¹⁶⁶ These levels translated to chromium 6 levels a full order of magnitude above the 0.2 $\mu\text{g}/\text{L}$ PHG.

FIGURE 22

Chromium Levels in Drinking Water Sources

All detections represent total chromium levels reported above the Public Health Goal standard of 2.5 mg/L in wells used as sources of drinking water.

Source: Data from the Department of Health Services (DHS) Drinking Water Database (October 1999–October 2000); compiled by LFR Levine-Fricke; mapped by NRDC.



In January 2001, the Department of Health Services ordered more than 3,000 water systems in the state to test for chromium 6 and report back to the agency by 2003.¹⁶⁷ Congressman Adam Schiff (D-Burbank) also urged the National Toxicology Program to launch a definitive study on whether chromium 6 can cause cancer from ingestion in drinking water.¹⁶⁸

CASE STUDIES

Although comprehensive tests have not yet been conducted, the highest total chromium levels, based on measurements taken over the last six months, appear to be in the Antelope, San Fernando, and San Gabriel Valleys, and around the Yolo/Solano county border.¹⁶⁹

The Department of Health Services' Drinking Water Database contains the results of sampling for total chromium, rather than chromium 6. Figure 22 is a plot of most of the samples taken in the one year period between October 1999 and October 2000

that exceeded the 2.5 µg/L PHG for total chromium. A total of 335 samples collected during that period exceeded the limit. The highest number of such exceedances was in Burbank, followed by the Travis Air Force Base area, in Solano County. Figure 22 also shows that some of the highest *levels* of chromium detection were also in those two areas.

High levels were also recorded by the Los Angeles County monitors, in response to the Board of Supervisors' requests for additional monitoring. In November, news reports revealed that 14 wells in Los Angeles County had registered chromium 6 levels above 10 ppb (50 times the new PHG), and that all of them were in the Antelope Valley. Concentrations in some of the wells were over 17 ppb.¹⁷⁰

The highest levels recorded in the Drinking Water Database (between 31 and 61) were all around the San Fernando and San Gabriel Valleys, and in the Los Angeles/Glendale/South Pasadena area. Moreover, Department of Health Services officials have noted that the levels in the San Fernando Valley have been increasing, and are expected to continue to increase.¹⁷¹ This may well be due to the fact that chromium 6 released into the environment long ago is continuing to make its way into the groundwater.

Lockheed Martin Corporation's San Fernando Valley operations have been linked to some of the chromium contamination in the area. The company has admitted to using chromium 6 as a rust inhibitor in cooling towers in its San Fernando Valley plant until 1966 and discharging the used coolant into the ground without treatment.¹⁷² Handwritten logs from workers also show discharges of chromium 6-laden waters to surface water bodies, with concentrations as high as 80,000 parts per billion.¹⁷³ Lockheed is not alone, though, as nearly 200 industrial sites around the valley are being inspected as possible sources of the pollution.¹⁷⁴

SPECIFIC SOURCES

Knowing where elevated levels of contaminants exist in our groundwater basins is an essential part of being able to regulate and protect the resource. However, without information that traces contaminants back to their sources, little can be done to stop further contamination from occurring. This section presents information NRDC obtained regarding several sources of groundwater pollution that are believed to be among the most significant in terms of the amount of groundwater they have affected. NRDC selected seven sources—leaking underground storage tanks, natural sources, agriculture, land disposal, septage, industrial point sources, and resource extraction—for the following reasons. First, these sources represent a wide range of human activity (from residential to industrial to rural), as well as including natural sources, which have contributed significantly to existing groundwater contamination. Second, this list includes sources that were most prevalent early in California's history (such as resource extraction), those that became an issue much later and only relatively recently came to public attention (such as underground storage tanks), and those for which there is still little regulatory attention devoted (such as agriculture). Third, these sources contribute to the presence of all of the contaminants discussed

in the preceding section, contaminants that are significant contributors to groundwater quality degradation in California.

Leaking Underground Storage Tanks (LUSTs)

Underground storage tanks leak toxic chemicals into the soil and groundwater in every county in California.¹⁷⁵ Underground tanks, and the problems associated with them, are extremely widespread. As of January 16, 2001, there were more than 43,000 active petroleum underground storage tanks registered in the state, and about 4,500 active tanks storing hazardous substances other than petroleum.¹⁷⁶ Almost 10 percent of those 48,000 tanks still do not meet upgrade specifications that were required to be in place by December 22, 1998, and more than 10 percent lack approved leak detection systems.¹⁷⁷ It is thus unsurprising that the 305(b) Report finds that leaking tanks contaminate more groundwater than any other single source.

There were underground storage tanks in California at least as early as World War II. At that time, there was a booming military presence in the state, in part due to the war in the Pacific, and underground storage tanks at military bases were known to hold petroleum products, various fuels, and other toxic substances. However, no leak detection devices were in place.¹⁷⁸ It was not until the early 1970s that the first leaking underground storage tanks (LUSTs) were noticed, at naval bases in California. Industrial tanks next came to the attention of government officials in 1984, when groundwater in the Silicon Valley was found to be contaminated by solvents used in the electronics industry.¹⁷⁹

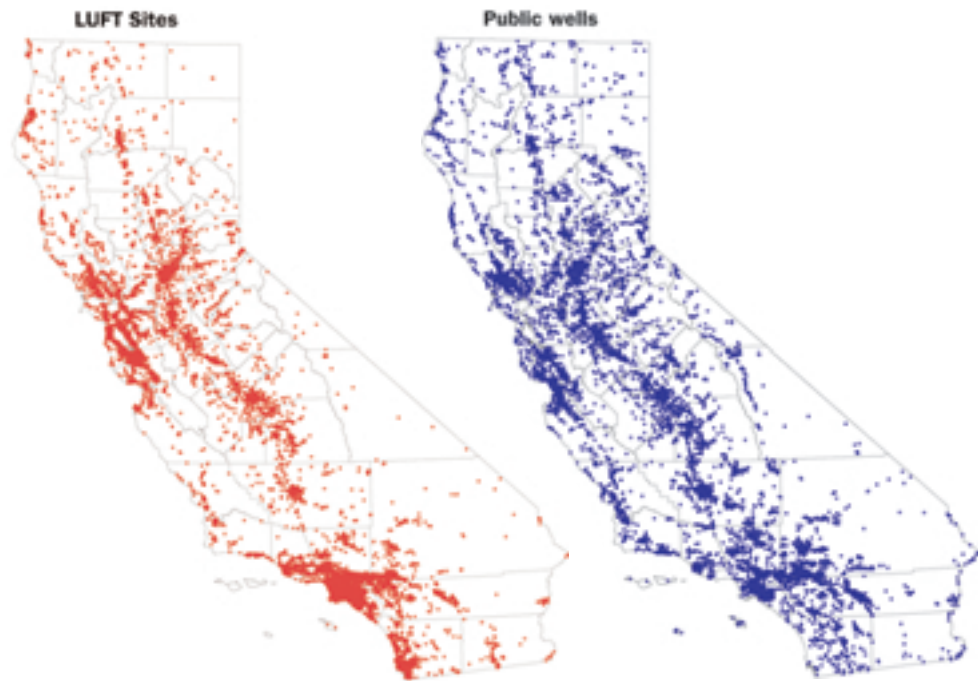
The realization of the LUST problem prompted legislation requiring tank inspections, and the numbers of known sites sky-rocketed. In 1980, only eight cases of LUSTs were reported in California, as compared to 3,954 reports in 1990.¹⁸⁰ In 1987, the State Water Board suspected that between seven and 20 percent of all of the tanks in California were leaking,¹⁸¹ and in 1994, fully one fourth of the known underground storage tanks in the Los Angeles area were known to be leaking.¹⁸²

Most underground storage tanks contain gasoline, with industrial facilities also commonly storing petroleum solvents and oils, and Naval facilities most often housing gasoline and diesel fuels, oil and lubricants. The hazardous components in these fuels, oils and solvents often include chemicals such as benzene, ethyl benzene, lead, and ethylene dibromide.¹⁸³

Present-day information on LUSTs is available through the State Water Board, and two separate reports have processed those Water Board data in the last few years. The University of California researchers who prepared the report on MTBE in 1998 for the Governor and the Legislature (see Pages 37–39) reviewed State Water Board documents and found that, as of June 30, 1998, the state knew of 32,779 sites where chemical compounds had escaped from underground storage tanks to the environment, 90 percent of which involved petroleum products.¹⁸⁴ Just two years later, the Environmental Working Group looked at State Water Board records and found that the number of known LUSTs since 1970 was up to almost 36,000. They also found that regulators had failed to order the cleanup of 90 percent of the state's leaking tanks.¹⁸⁵

FIGURE 23
LUFT Sites and Public Wells

Source: "Methyl Tert Butyl Ether (MTBE) Impacts to California Groundwater," By Anne M. Happel and Brendan P. Doohar, Environmental Protection Department, Lawrence Livermore National Laboratory (March 25, 1999), UCRL-MI-133696.



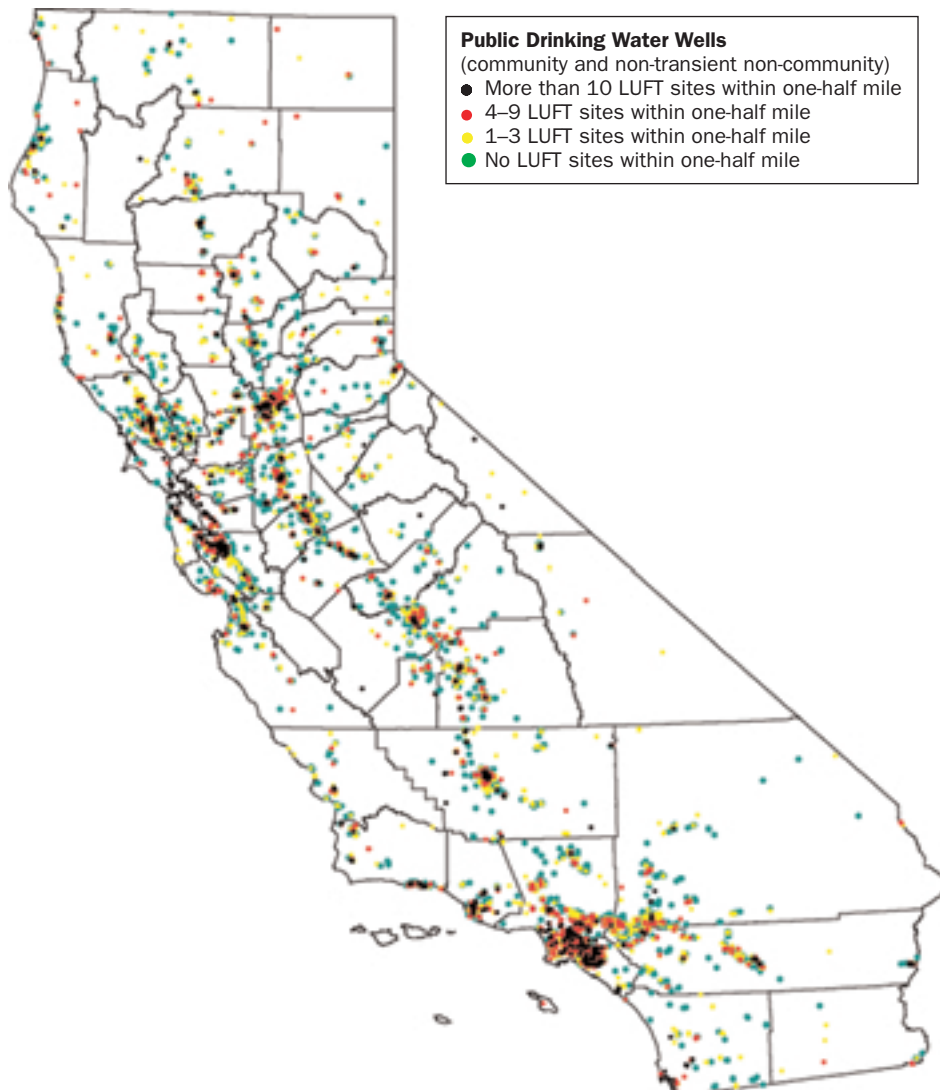
Not surprisingly, many of these leaks have reached groundwater. In June 1998, the State Water Board listed a total of 5,738 open¹⁸⁶ leaking underground fuel tank (or LUFT) sites¹⁸⁷ where groundwater had been contaminated by gasoline.¹⁸⁸ Two years later, the number of LUFT sites confirmed to be contaminating drinking water was over 6,500.¹⁸⁹ Figure 23 shows the locations of all the LUFT sites and public wells known to the State Water Board. Figure 24 specifically shows the proximity of the known LUFT sites to public drinking water wells.

Significantly, the responsible regulatory agencies appear to have targeted those sites contaminating soil more aggressively than those that contaminate groundwater. Of the 14,470 sites known to contaminate groundwater, only 44 percent have been closed,¹⁹⁰ whereas 72 percent of the 17,602 sites known to contaminate soil have been closed.¹⁹¹

Finally, Table 7, from the Environmental Working Group's report on leaking tank sites, shows the distribution of the leaking tank sites of which the state is aware.¹⁹² Consistent with the contents of these tanks, the vast majority of the contaminants that have leaked from underground tanks over the last 30 years have been petroleum products: 55 percent of the LUSTs have leaked gasoline, 17 percent diesel, and another 14 percent other vehicle fuel and waste oil.¹⁹³ Some argue that fuels are of relatively less concern, due to the fact that they biodegrade in the environment; however, the presence of fuel additives such as MTBE make this problem more complicated.

FIGURE 24
LUFT Sites Located Within One-Half Mile of Public Drinking Water Wells

Source: "Methyl Tert Butyl Ether (MTBE) Impacts to California Groundwater," By Anne M. Happel and Brendan P. Dooher, Environmental Protection Department, Lawrence Livermore National Laboratory (March 25, 1999), UCRL-MI-133696.



Natural Sources

Although there may be no anthropogenic change in water quality that threatens to, or does, restrict the uses to which the water can be put, in order to protect public health and to be able to make critical policy decisions regarding water management, it is important to recognize the existence of these natural impairments and to delineate the areas that are so affected. Regulators and other officials must be aware of which waters are safe for consumption and other uses, and which are not. If, for example, one wanted to store water underground for later use, it would be essential to know which areas are free of harmful constituents in order to avoid contaminating the previously relatively uncontaminated water through the storage process.

TABLE 7**Leaking Tank Sites by County**

This table, presented in the Environmental Working Group's "Uncontrolled LUSTs" report, shows the number of sites at which underground storage tanks are known to be leaking. The "open" sites are being investigated and/or remediated by the State Water Resources Control Board (SWRCB). The "closed" sites are no longer under SWRCB control but may be sources of ongoing contamination. The final column indicates the number of sites at which the contaminants have been detected in nearby groundwater that is used as drinking water.

Source: Environmental Working Group, "Uncontrolled LUSTs," (July 2000).

Rank	County	Total sites	Open sites	Closed sites	Sites that contaminate drinking water
1	Los Angeles	5,497	2,104	3,393	63
2	San Diego	3,274	1,518	1,756	798
3	Orange	2,600	1,177	1,423	845
4	Alameda	2,288	1,129	1,159	24
5	Santa Clara	2,211	764	1,447	149
6	San Francisco	1,349	318	1,031	0
7	Ventura	1,261	372	889	0
8	Riverside	1,129	448	681	296
9	San Mateo	1,125	682	443	24
10	Sacramento	1,119	545	574	254
11	Sonoma	1,028	533	495	646
12	Kern	1,008	260	748	98
13	San Bernardino	1,001	529	472	165
14	San Joaquin	904	542	362	310
15	Contra Costa	808	372	436	107
16	Santa Barbara	749	281	468	220
17	Fresno	711	378	333	129
18	Humboldt	516	342	174	227
19	Tulare	466	200	266	149
20	Solano	453	182	271	65
21	Stanislaus	425	197	228	167
22	Monterey	399	221	178	8
23	Placer	391	271	120	192
24	Merced	363	153	210	142
25	Mendocino	358	189	169	145
26	Marin	331	151	180	6
27	Napa	320	149	171	6
28	Santa Cruz	304	157	147	4
29	Shasta	294	89	205	154
30	Yolo	249	112	137	111
31	Butte	228	83	145	113
32	Yuba	204	153	51	47
33	Madera	201	86	115	15
34	San Luis Obispo	199	73	126	3
35	Imperial	185	33	152	43
36	Nevada	185	108	77	86
37	Siskiyou	174	73	101	73
38	Kings	173	77	96	100
39	El Dorado	154	85	69	85
40	Tehama	134	39	95	53
41	Tuolumne	127	90	37	51
42	Inyo	99	50	49	43
43	Del Norte	97	56	41	52
44	Calaveras	95	56	39	24
45	Sutter	86	46	40	32
46	Lake	83	48	35	33
47	Mariposa	79	30	49	28
48	Trinity	74	43	31	21
49	Mono	66	34	32	22
50	Amador	58	40	18	23
51	Plumas	54	10	44	27
52	Colusa	52	38	14	20
53	San Benito	52	13	39	1
54	Glenn	40	16	24	21
55	Lassen	30	21	9	22
56	Alpine	13	4	9	5
57	Sierra	12	9	3	5
58	Modoc	11	5	6	5
Total		35,896	15,784	20,112	6,557

In addition, waters recognized as being impaired by “natural sources” may, in some cases, actually have been influenced by human activity. It is quite possible, for example, that runoff from agricultural irrigation in one area would transport sediments and result in the presence of “naturally-occurring” salinity in another area.¹⁹⁴

Agriculture

According to many estimates, agriculture is the greatest source of water pollution throughout the United States.²⁰¹

Agriculture can contribute to groundwater contamination in multiple ways. Perhaps the earliest agricultural impact came from coastal agriculture, which led indirectly to seawater intrusion, simply by virtue of the huge amounts of water that were withdrawn from the ground to support it. From the 1850s to the early 1900s, the principal use of water in the coastal regions was irrigated agriculture,²⁰² and “[b]y 1865, there were close to 500 wells in the [Santa Clara] Valley.”²⁰³ The pumps drained so much water out of the aquifers that the groundwater elevations in the basins were lowered below sea level, and the direction of groundwater flow shifted. Seawater intrusion was noticed in California as early as 1906, in San Diego County.²⁰⁴

A much more direct way in which agriculture can lead to groundwater contamination is through the application of fertilizers (containing high levels of nitrogen) and pesticides²⁰⁵ to the land. Irrigation runoff containing fertilizers and pesticides has significantly polluted areas in the Central Valley.²⁰⁶ In addition to these direct, intentional applications, the vast quantities of animal waste generated by CAFOs are often disposed of in manners that cause nitrogen-based compounds to leach into the ground and contaminate the groundwater.²⁰⁷ As a result, millions of pounds of nitrates (in the form of fertilizers and manure) and pesticides are applied to cropland every year.²⁰⁸

Finally, irrigation itself can lead to serious contamination problems, by mobilizing salts and trace elements such as selenium that are already present in the soil. In addition, irrigation with reclaimed sewage water and the agricultural application of sewage sludge as a soil amendment can allow pathogens to enter the groundwater.²⁰⁹

Irrigation runoff containing fertilizers and pesticides has significantly polluted areas in the Central Valley.

Land Disposal

Although landfills built after 1984 are required to comply with certain regulatory design standards, most of California's landfills were built before 1984 and are leaking contaminants into the groundwater.²¹⁰ The first attempt at sanitary landfilling in California began in the 1940s under Jean Vincenz, the Fresno Director of Public Works. The California Department of Health Services later became one of the first state health departments in the nation to establish landfill standards.²¹¹ However, the U.S. Environmental Protection Agency warns that “even the best liner and leachate collection systems will ultimately fail due to natural deterioration.”²¹²

California now has more than 2,300 active and inactive land disposal sites, “most of which are simply large holes in the ground filled with a variety of hazardous and non-hazardous waste and covered with dirt.”²¹³ A 1990 study of 356 California landfills found 240 of them (67 percent) emitting one or more toxic solvents.²¹⁴ The

RADON

Radon is an odorless, colorless, radioactive gas that often occurs in groundwater as a result of the decay of naturally-occurring radioactive rock. It is considered by the National Academy of Sciences and other health officials to be a “known human carcinogen.”¹⁹⁵

Although radon itself does not appear in the 305(b) Report, and radiation as a whole is only reported in one region, that is likely because the Regional Water Boards do not test for it.¹⁹⁶ Furthermore, because California has no MCL for radon, it would be impossible for a Regional Water Board to determine that a given concentration level was impairing a water body's use as drinking water. That threshold determination is necessary, though, for the listing of a water body in the 305(b) Report. Thus, it is of little interest (and little significance) that radon impairment is not listed in the 305(b) Report.

However, information about safe levels of radon exposure do exist. In 1995, EPA proposed a health standard to limit radon to 300 picocuries per liter of water (pCi/L).¹⁹⁷ At that level, EPA estimated the risk posed to be one fatal cancer in every 5,000 people exposed,¹⁹⁸ much higher than is normally allowed. Still, no standard was ever finalized. Amendments to the Safe Drinking Water Act in 1996 required that a standard be set by January 2001.¹⁹⁹ However, EPA missed that deadline as well, and, on November 17, 2000, NRDC filed a formal notice of intent to sue to force EPA to complete that process.

In 1995, NRDC found the highest levels of radon in California to be in the water systems around Fresno and the Bay Area. Levels in Fresno ranged from 146 to 2,708 pCi/L. In the Bay Area, the levels were: Contra Costa Water District, 100 to 870 pCi/L; City of Pleasanton, 251 to 677 pCi/L; Alameda County Water District, 200 to 590 pCi/L; San Francisco Water Department, 1 to 549 pCi/L; and North Marin Water District, 356 to 373 pCi/L.²⁰⁰

For the present report, NRDC again analyzed the recent one year of data from the Department of Health Services Drinking Water database and found that, for the October 1999 to October 2000 period, some of the highest levels were around Sacramento and along the path of Interstate 10 through Los Angeles County and along the western half of the San Bernardino-Riverside County border. Although the 300 pCi/L standard allows considerably more risk than EPA would normally accept, NRDC used that threshold to review the data, and the map in Figure 25 shows the sampling points in which the level exceeded that standard.

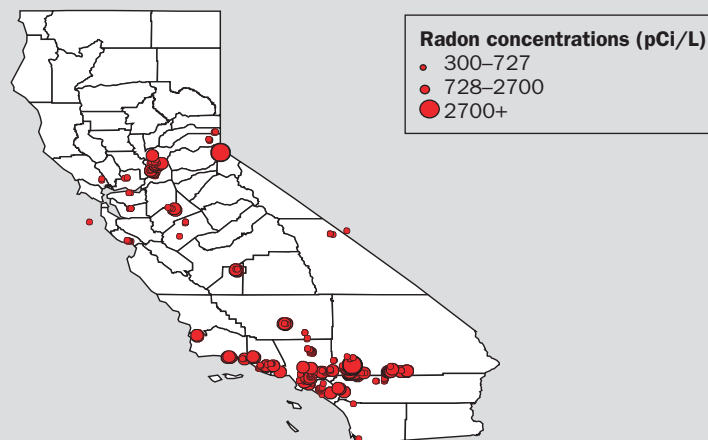
Again, although the presence of radon is a totally natural phenomenon, knowledge of where it is most prevalent is essential to effective and safe management of groundwater basins in a manner that protects public health.

FIGURE 25

Radon in Drinking Water Sources

Since 1995, EPA's proposed health standard for radon in drinking water has been 300 picocuries per liter (pCi/L), which translates to a risk level of about one fatal cancer in every 5,000 people exposed. No standard has ever been finalized. This map shows only those sites where a well used as a source of drinking water was sampled between October 1999 and October 2000 and found to contain concentrations of radon in excess of that 300 pCi/L threshold. It is based on data compiled by the Department of Health Services.

Source: Data from the Department of Health Services (DHS) Drinking Water Database (October 1999–October 2000); compiled by LFR; mapped by NRDC.



California Integrated Waste Management Board listed 17 landfills as violating handling and disposal standards as of November 1999, mostly involving methane gas production, but some also including problems with their closure plans.²¹⁵ Even minor leaks from landfills cause significant pollution since landfill leachate has been measured to be 20 to 100 times more potent than raw sewage.²¹⁶

In 1991, studies performed under the California solid waste assessment tests (SWAT) concluded that landfill leachate pollutes groundwater regardless of minimal precipitation. Eighty percent of California's landfills were found to be polluting groundwater, even though most of them were located in areas that experienced less than 25 inches of precipitation per year.²¹⁷

Septage

The first septic tank was established in England around 1900. It was, in essence, a watertight, underground, mini sewage treatment plant.²¹⁸ Today, many residences are not connected to a sanitary sewer system. One fourth of American homes, and about one third of the United States' population, still use some form of private, on-site, sewage disposal system, or "septic system," to manage their domestic wastes.²¹⁹ The material released from these systems (known as "septage") can have a negative effect on groundwater quality.

Pathogens represent one potentially problematic constituent within septage; they can infect people and animals that come in contact with the affected water sources. Septic systems are the most commonly reported cause of groundwater contamination resulting in waterborne disease outbreaks.²²⁰ Children, the elderly, and people with depressed immune systems are more vulnerable to infection than are healthy adults, but all can be infected if the contamination occurs at a high enough level.²²¹

Septic systems also release nitrogenous wastes. If the systems are not adequately constructed and maintained, nitrogen can leach into nearby groundwater at levels that present a significant human health threat. On the Central Coast, Los Osos-Baywood groundwater is impaired by septic tank discharges leading to nitrate exceedances, but no sewer system is planned to remedy the problem.²²² Septic systems are increasingly being used along the North Coast, as well.²²³ Because the 10- to 15-year design life of many septic systems built during the 1960s and 1970s is now exceeded, groundwater contamination caused by septic system failure probably will increase in the future. The Los Angeles Regional Water Quality Control Board recently concluded that septic systems in Malibu are causing groundwater pollution, as well as being a primary cause of the polluted beach water at the world-famous Surfrider Beach.²²⁴

Although nitrates and pathogens are the most common types of contaminants released by septic systems, there are others, as well. EPA studies indicate that many septic systems are being misused by businesses such as dry cleaners, automotive repair shops, service stations, and car dealerships. According to the EPA, "These businesses inject as much as four million pounds of spilled gasoline, oil, engine cleaning solvents, brake and transmission fluids, antifreeze, and other industrial chemicals into the ground per year—enough to pollute trillions of gallons of drinking

water.”²²⁵ Especially difficult in the containment of these wastes is the fact that many septic systems are designed to release effluent that is only partially treated, relying on percolation through soil to remove organic chemicals, nutrients, and bacteria.

New, statewide regulations are being adopted in California to regulate septic system contamination, but those systems are not yet in place, and it will be several years before their impacts can be assessed (see page 78).

Industrial Point Sources

Industrial point source pollution mostly involves volatile organic compounds such as trichloroethylene, vinyl chloride, carbon tetrachloride, toluene, benzene, ethylene dibromide (EDB), and xylene, and other organic chemicals.²²⁶

Industrial chemicals, such as solvents, are among the principal contaminants found in California groundwater.²²⁷ Most solvents are volatile organic compounds, or “VOCs,” which have presented a particular problem in the aquifers of the San Gabriel and San Fernando Valleys.²²⁸ Industrial chemicals are used in the production of (or are a manufacturing byproduct of) everything from solvents, to lubricants, to pesticides, to plastics, to adhesives, to degreasers. They are of particular concern because they can be highly toxic, even at low concentrations.²²⁹

There is also a significant amount of inorganic contamination that comes from industrial point sources. For example, the recent concern in Southern California over hexavalent chromium in wells in the San Fernando Valley is likely the result of industrial point source discharges. As noted above, existing information on the source of this sort of contamination, and possibly many forms of industrial contamination, may indicate that these types of pollution are primarily a remnant of the past. However, the data have not yet been presented, to our knowledge, in a manner that would provide conclusive evidence of this claim.

The related category of the defense industry is responsible for a great deal of localized contamination around military and aerospace facilities. Typical contaminants at these locations are perchlorate and N-nitrosodimethylamine (NDMA).²³⁰

Resource Extraction (Mining)

The mining industry emerged in California during the Gold Rush era (1848–53) and began aggressively extracting metals from the subsurface through both physical and chemical methods. Twelve million ounces of gold were produced in those first five years, leaving behind open mines and huge piles of mine tailings. Rain water that hit the mines and the mine tailings would dissolve the metals and other minerals, becoming a toxic sludge known as “acid-mine drainage.” This drainage would then disperse the metals and other minerals, often into the groundwater.

With the advent of the steam-powered drill and dynamite in the 1860s, new processes were adopted with an even greater environmental impact. Once the ore was exploded to the surface, it was crushed by giant hammers on crankshafts, in what was known as a stamp mill. The crushed ore was then chemically treated with mercury and arsenic in order to tease the gold out of it. It is this last step that has generated some of the most toxic waste sites in the United States.²³⁹

PERCHLORATE

Perchlorate is used primarily as a component of solid rocket fuel and must be replaced regularly in the nation's missile and rocket inventory. It was first discovered as a contaminant of drinking water in 1997 and has been a problem primarily in groundwater bodies in proximity to aerospace industry facilities.²³¹

Because the Department of Health Services has classified perchlorate as an "unregulated chemical for which monitoring is required,"²³² there is no MCL for the chemical. Consequently, even extremely high levels will not show up as "exceedances" on Figure 5, as there is no MCL to exceed. However, because monitoring is required, there are some data available through the Drinking Water Database. The Department has also established an 18 µg/L "action level"—a non-enforceable, health-based advisory level for contaminants that lack primary MCLs—to protect the public health.²³³

The Department of Health Services has detected perchlorate in 185 samples, 8.4 percent of the samples in which they tested for it, and in 14 percent of the public water systems tested. In 46 of the locations where it was detected, the perchlorate level was above the 18 µg/L action level.²³⁴ Almost all of the detections have been in Southern California, mostly in Los Angeles, San Bernardino, and Riverside counties.²³⁵

Looking at the one year of data in the Drinking Water Database from October 1999 to October 2000, there were 95 samples in which the perchlorate level exceeded the 18 µg/L action level. The highest levels of perchlorate were near the Los Angeles-San Bernardino county line, with the average concentration among the exceedances in Rialto reaching 403 µg/L, and the average among the exceedances in the Cordova Water Service system, in the San Dimas area, reaching 278 µg/L. Each of these areas is near at least one aerospace industry facility.²³⁶ The only other citywide or zip-code-wide area in which the average concentration of those samples that exceeded the action level even came close to 100 µg/L was in the La Puente area of Los Angeles County, where there were six exceedances during the year, averaging 89.8 µg/L.

In 1997, after EPA had listed four parts of the aquifer beneath the San Gabriel Valley on the National Priorities List due to VOC contamination from industrial sources, perchlorate²³⁷ was found in the groundwater as well, further increasing concerns about maintaining an adequate water supply for the Valley. The estimated cleanup cost for the aquifer is well into the hundreds of millions of dollars, and the contamination is spreading and threatening another aquifer that provides drinking water to more than half of Los Angeles County.²³⁸

Since this type of gold mining required mercury, demand for mercury mining increased as well, to the point that the Coast Ranges of California contained the world's second largest mercury mines by the late 19th century.²⁴⁰ Over 100,000 tons of mercury—a fatal toxin²⁴¹—were removed from the mountains to be used in gold mining in the Sierras. An approximate 26,000,000 pounds of mercury were used for gold mining throughout the state.²⁴² "Geologists today estimate that some 7,600 tons of this mercury were lost into the rivers of the central Sierra Nevada alone."²⁴³

Today, many of the historic mines have long been abandoned, but that does not mean that they no longer present a threat to California's water quality. Rain still

WELL ABANDONMENT

Although abandoned wells are not considered to be of concern for the generation of contaminants, they can serve as a source for the spread of existing contaminants. Because wells can facilitate the spread of pollutants into interconnected groundwater sources, the state requires well destruction that inhibits water flow between aquifers. A closed well must therefore be filled with monolithic material such as clay layers to prevent such spreading. Unfortunately, the expense of sealing a well has caused many well-owners to abandon and hide polluted wells. This has led to serious problems in many areas. Two areas in which the problems associated with abandoned wells were recently documented are the Oxnard Plain of Ventura County and the San Francisco Bay area.²⁵¹ In recognition of this danger, California officially defined well abandonment as a misdemeanor in 1988,²⁵² and as of March 2001, there is an effort underway to pass legislation that will provide financial incentives for proper well demolition.²⁵³

percolates through abandoned mine shafts, fractures and fissures, as well as through waste heaps of removed ore, creating acid-mine drainage. Beneath Iron Mountain, near Redding, California, the most acidic waters ever measured are percolating through an underground mine.²⁴⁴ These waters are so acidic that scientists from the U.S. Geological Survey had to rely on the concept of negative pH in order to characterize the water the mine releases (pH = -3.6).²⁴⁵ Located at the site of a mineral-rich, "massive sulfide," ore deposit, this mine once produced copper, zinc, gold, silver, and pyrite (fools' gold). Today, its primary production comes in the form of hot, acidic waters, dripping off of huge, underground stalactites in abandoned mine shafts. Since this site, located upstream from the City of Redding, poses a likely threat of drinking water contamination, the city has been forced to develop contingency plans for alternate sources of water. Recent developments include a settlement between the State of California, and Aventis CropSciences USA, Inc. that will help fund future cleanup efforts, which are expected to cost as much as \$1 billion²⁴⁶

A little farther south, in the Sierra Nevada Range, there is a similar situation. The Penn Mine, in Calaveras County, has contaminated groundwater that continues to flow through a fractured-rock aquifer towards Camanche Reservoir, threatening the integrity of this water supply.²⁴⁷ Near Sacramento, zinc and cadmium concentrations are of concern in rivers downstream from mined areas.²⁴⁸ In fact, about 95 percent of the copper, zinc, and cadmium measured in the Sacramento River is thought to come from inactive mines.²⁴⁹

Acid-mine drainage also leaches minerals from exposed rock and mine tailings in forms that present real health threats to the surrounding environment, wildlife, and communities. In Alpine County, in the Lahontan Region, acid-mine drainage percolating through groundwater at the Leviathan Mine is releasing aluminum, arsenic, copper, iron and nickel into nearby Bryant and Leviathan creeks, tributaries to the agriculturally and recreationally valuable Carson River.²⁵⁰

A PATCHWORK PICTURE: GROUNDWATER ASSESSMENT IN CALIFORNIA



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

Undeniably, California's people and businesses depend upon the existence of a safe and plentiful supply of groundwater. The basis for any successful management program is reliable data. It is the first step, without which policy-makers are unable to make decisions to ensure that those supplies are provided. However, no single entity currently provides policy-makers, much less the general public, with information on the quality of this essential resource—whether in individual basins or throughout the state as a whole. Each of the agencies mentioned in the previous chapters collects useful information, but their data are scattered and inconsistent; even aggregated, these data do not produce a comprehensive picture of the condition of California's groundwater. In fact, due to data inaccuracies, the picture created by such a compilation is not even accurate in what it purports to represent.

The fact that a singular, systematic, and comprehensive groundwater monitoring program does not currently exist in California has many policy implications. A pointed example arises from the claim, made by some experts, that certain types of industries (and therefore, the types of contaminants generated exclusively by those industries) are now adequately regulated and pose no ongoing threat to California's groundwater resources. According to this theory, to the extent that such contaminants continue to pose a problem, they do so only as "legacy pollution"—residues of an earlier era, when awareness was limited and regulation (if it existed at all) was less stringent.¹ If true, this claim would have significant implications for management, but without better status and trends data, this claim cannot be adequately addressed. Thus, this claim only further emphasizes the need for improved information.²

This chapter discusses some of the many problems in the current monitoring system and, as a result, the limitations inherent in the data presented in the preceding chapters. These problems are divided into four groups. The first section, "How Clean is Clean?" discusses the use of numerical water quality standards as benchmarks in the evaluation of groundwater quality and some of the problems that system creates. The second section, "Incomplete and Unreliable Data," focuses primarily on the State Water Board's 305(b) Report (which is supposed to contain a comprehensive, statewide

water quality assessment), and the myriad problems with the data presented therein. The third section, “My Way,” discusses the lack of inter-agency coordination, and the consequent inconsistencies in the data prepared by different agencies. The fourth and final section, “That’s Not My Department,” recognizes that some agencies do collect systematic data but notes that those agencies generally are not attempting to assess the overall state of California’s groundwater as a resource.

THE PROBLEMS

How Clean Is Clean?

Most of the agencies that collected the data presented in the previous chapters focused less on the objective level at which contaminants were detected in the water than on whether those levels exceeded some specific standard. Numerical thresholds have been established for many constituents to indicate the maximum concentration of those constituents in a water body that will still allow various uses of the water. The numerical standards differ according to the uses to which a water body is to be put.

In the case of the 305(b) Report, the Regional Water Boards list a water body as “impaired” only if it exceeds the numerical standard associated with one of the “beneficial uses” designated for that water body. A water body may therefore be determined to be “up to par” simply because the *par* is not very high. Fortunately, most of California’s groundwater basins have been assigned the most rigorous of standards, those for drinking water. Those waters will only qualify as “clean” if the concentrations of the various contaminants do not exceed the applicable MCLs.

However, this is not true of all water bodies in the state. Thus, there may be areas of contaminated groundwater that are left out of the 305(b) Report not because they are clean but because the state has essentially written them off by removing drinking water as a beneficial use. Conversely, the 305(b) Report lists water bodies as “impaired” without indicating the applicable beneficial use that has been violated, thus obscuring the severity of the impairment. Finally, if a water body does meet the applicable standards, it is deemed clean no matter how close to the maximum acceptable limit the contaminant levels within it are.³

The Department of Health Services’ Drinking Water Database does list the concentrations of each constituent tested, but, in its own way, the Department also focuses primarily on whether each water body has exceeded a specific threshold. Because the Department is concerned with public health, its focus is on drinking water standards. The Drinking Water Database lists the MCL for the constituents for which it tests, providing an easy way to determine where there has been an exceedance of that standard.

If a water body is within those limits, however, the database does not facilitate a determination of whether—or the degree to which—it may nevertheless harbor some contaminants. That is because background levels are not reported in the database, so the presence of unnaturally high levels of contaminants is not highlighted (unless, again, the level exceeds the MCL). Similarly, there is no mechanism for tracking the changing composition of a water body over time. As long as the water body is below

its MCLs, it is deemed “clean.” This problem also applies to the 305(b) Report. In failing to anticipate approaching contamination, these two systems also fail to prevent, or, where appropriate, to expeditiously remediate contaminated waters.

Moreover, because of the agencies’ focus on existing standards, the existence of reliable standards for all contaminants of concern is essential to an effective program. However, MCLs have not even been established for the vast majority of contaminants. That absence significantly undercuts the utility of the Department of Health Services’ monitoring program, as well as much of the State Water Board’s program.

Finally, as was discussed previously with respect to certain specific compounds, NRDC believes that some of the MCLs are set at inappropriate levels. Thus, although there may not be an exceedance of an MCL, that does not necessarily guarantee that the water is safe to drink.

Incomplete and Unreliable Data

California’s nine Regional Water Boards are responsible for monitoring and protecting the water quality within their jurisdictions, and they must provide assessments to the state every two years in what is known as the “305(b)” process. However, the reality is that the 305(b) Report—the central document in the water quality assessment system—is neither thorough nor reliable. Similarly, in its current form, the Department of Health Services’ Drinking Water Source Assessment and Protection Program is destined to produce extremely limited data on the topic it is designed to address—the nature and scope of existing threats to drinking water sources.

Incompleteness. When asked about the assessment methods employed, individuals at the various Regional Water Boards readily concede the inadequacy of their groundwater quality data. Staff members working at the Regional Water Boards generally request information through newspapers, telephone calls and other means of communication. They use information from sampling that occurred at cleanup sites and known problem areas.⁴ The Central Valley derives its information from the evaluation of site-specific projects.⁵ The Colorado River Basin Region relies on data from municipal water suppliers regulated under the Safe Drinking Water Act.⁶ The San Diego Region derives most of its information from military cleanup site sampling.⁷ As a result, the 305(b) Report does not contain a thorough analysis of the quality of the state’s groundwater resources and must, instead, be viewed more as a compilation of anecdotal data and haphazard testing.⁸

The report itself indicates that only a portion of the state’s waters are assessed. The 1998 update to the 305(b) Report stated that there were over 82,000 square miles of groundwater bodies in the database from which the report was drawn, yet only 63,581 square miles were assessed.⁹ The 2000 report only assesses 62,652 square miles, a slight decrease from 1998.¹⁰ Therefore, by its own numbers, the current report only represents about three fourths of the total groundwater in the state.¹¹

A primary reason for these shortcomings may be lack of resources. Regional Water Board representatives report that severely limited funding makes it difficult, if not impossible, for them to conduct tests in any consistent and comprehensive

The 305(b) Report does not contain a thorough analysis of the quality of the state’s groundwater resources and must, instead, be viewed more as a compilation of anecdotal data and haphazard testing.

manner. Since surface water can be tested with greater ease and less expense than groundwater, the regions tend to focus on these bodies of waters (although they, too, are under-monitored, based on the percent assessed), only assessing groundwater on a case-by-case basis. A detailed analysis of the funding system is very difficult to obtain due, again, to the fragmented nature of the program. Funding is provided to several different programs under several different statutory schemes.¹²

Because there is no uniformity or comprehensiveness in the way the various Regional Water Boards conduct their assessments, regions that reported more contamination (such as the Central Valley, Central Coast, North Coast and Lahontan) may not actually have more contaminated waters, but may simply have made greater efforts in collecting information. For example, calculations of regional 305(b) data show that more than 90 percent of the areas listed as impaired by metals and more than 80 percent of the areas listed as impaired by salinity are in either the Central Valley or the Lahontan regions. At the other extreme, the Los Angeles Region reported no groundwater impaired by organic compounds and only five square miles impaired by non-priority organics.

It is extremely unlikely that the distribution of these contaminants is truly so regionalized. For example, the lack of organic compounds reported in the groundwater basins in the Los Angeles region and the San Francisco Bay area contradicts other data presented in Chapter 3 of this report. As was discussed above, three Southern California counties (Los Angeles, Riverside, and San Bernardino) were among the worst in terms of the presence of organic compounds in their groundwater basins in 1987,¹³ and the Department of Health Services' Drinking Water Database shows a substantial number of drinking water wells around the Bay Area and in the South Coast in which organic compounds were detected in the drinking water over the last year.¹⁴

Finally, the report characterizes the size of water bodies based on their areal extent, with no discussion of their depths. Since water bodies are three-dimensional, this method fails to account accurately for the true volume of the water. This not only creates a misleading sense of the size of the water body, but it also suggests that groundwater is being measured at only one depth; furthermore, there are no data on its composition at other depths.

Problems regarding a lack of comprehensiveness are evident in other agencies' data as well. The Drinking Water Source Assessment and Protection Program discussed on pages 18–19 is a good example of a program with much potential but destined to produce data that are of very limited utility if it is completed in its current form. Perhaps the most significant limitation in the present system is that the Department of Health Services (DHS) received only \$7.5 million from the federal Drinking Water State Revolving Fund to administer this entire program and has few, if any, additional resources presently available to it.¹⁵ DHS therefore has only a few hundred dollars available to review completely each source area and potentially contaminating activities (PCAs). Other problems include the following:

- the magnitude of the threats is not conveyed, as PCAs are grouped by category. Furthermore, the program only records whether each category of PCAs is represented

in a given area, without any quantification of the number of the individual sources from each category that are present or their sizes;

- the reporting is intentionally general and does not identify the potential sources of contaminants;
- the program focuses on individual wells rather than on the watershed as a whole; even in the context of individual wells, the full recharge areas for the wells at issue are not assessed;
- the Department lacks the authority to take action based on its findings. As a result, once an assessment is completed, it cannot respond effectively to the potential threats.

Unreliability. The problems with the 305(b) Report go beyond a lack of comprehensiveness. Judging by assessments published in the 305(b) Report, many analysts at Regional Water Quality Control Boards may have made the assumption that an entire groundwater basin was impaired when some evidence of contamination was identified in a discrete part of the basin. This may or may not be true in any given case, but it would be difficult to justify such an assumption in every instance. Such an error could lead to a significant overestimation of impairment—although, as noted above, the incompleteness of the report and other errors make it difficult to tell whether, when all is said and done, the current report accurately estimates total contamination.

Even individual reports of impairment, which contribute to overall assessments published in the 305(b) Report, are not necessarily accurate. Some Regional Water Board representatives indicated that they estimate numbers based on expert observations and calculations.¹⁶ In the Central Valley, for example, where the vast majority of the metals impairment is reported, metals were found in two particular bodies of surface water where mines had operated until the 1980s. Metals were then *estimated* to have contaminated the groundwater, but no specific tests were ever performed.¹⁷ The only other region reporting metals, the Lahontan Region, concluded that geothermal springs and volcanic actions in the Mammoth area produced naturally occurring trace metals and arsenic.¹⁸ This region then analyzed the surface water near mines and, finding metals, estimated metals for the groundwater. The San Diego Region only systematically checks urban surface waters and reported salinity as a result of receiving information from individuals who tested various wells.

In addition, the data that do exist are often quite old. Although the current 305(b) Report is for the calendar year 2000, a representative from the Central Valley Region stated that the region last updated its data in 1996.¹⁹ Much of the region's data date back even earlier. A representative from the North Coast region claims to have contributed no groundwater information to the 305(b) Report since he first joined the region in 1991.²⁰ Further, as noted (Chapter 2, note 34), the figures in the tables showing the amount of groundwater impaired by various contaminants from various sources may actually include some waterbodies that are categorized as threatened, rather than impaired. Finally, the State Water Resources Control Board itself claims not to have updated its report since 1992 (see sidebar, "Disappearing Data," on Page 15).

One final way in which data can be rendered unreliable is through the use of production wells to collect groundwater samples for water quality assessment purposes. Production wells can provide a false indication of true groundwater conditions by mixing water from separate aquifers.²¹

As a result of its unreliability, the 305(b) Report likely underestimates the extent of impairment in many cases (such as when the report contains no data for a given area) and overestimates it in others (such as when unsubstantiated assumptions are made about basinwide contamination). In sum, the 305(b) Report is inaccurate in many respects.

“My Way”

Whether due to turf wars, honest differences of opinion, or their different focuses, different agencies often collect and organize information in different ways. This can be a serious impediment to the productive compilation of information. For example, both the State Water Board and the Department of Water Resources characterize the areal extent of groundwater basins. However, the two agencies arrive at disparate and irreconcilable numbers. Because the State Water Board does not even have estimates for the total areal extent of groundwater in the state, or in any given region, one is forced to perform statistical gymnastics and compare data from different agencies to try to determine the significance of the amount of contaminated water to the state as a whole. The resulting figures are hardly reliable, given the discrepancy between the two agencies’ numbers.

Moreover, the State Water Board and the Department of Water Resources (DWR) do not use all of the same regional boundaries. DWR divides the state into ten hydrologic regions, while the State Water Board divides it into nine. DWR treats the South Coast as a single region, while the State Water Board divides it into three (Los Angeles, Santa Ana, and San Diego). Similarly, the State Water Board lists a single Lahontan region and a single Central Valley region, while DWR divides the former in two and the latter in three. Although there is substantial correlation among the boundary lines the agencies do share, and there is an effort underway to fully harmonize those lines,²² for the moment, the differences make it difficult to provide any context for the State Water Board’s regional data, even if it were accurate.

“That’s Not My Department”

One agency, the Department of Health Services, attempts to assess waters in a systematic and ongoing manner. As indicated above, the data collected under the Safe Drinking Water Act, and stored in the Department’s Drinking Water Database, are quite extensive, in terms of the sheer volume of data. However, the data are also quite limited, due to the limited scope of the agency’s jurisdiction.

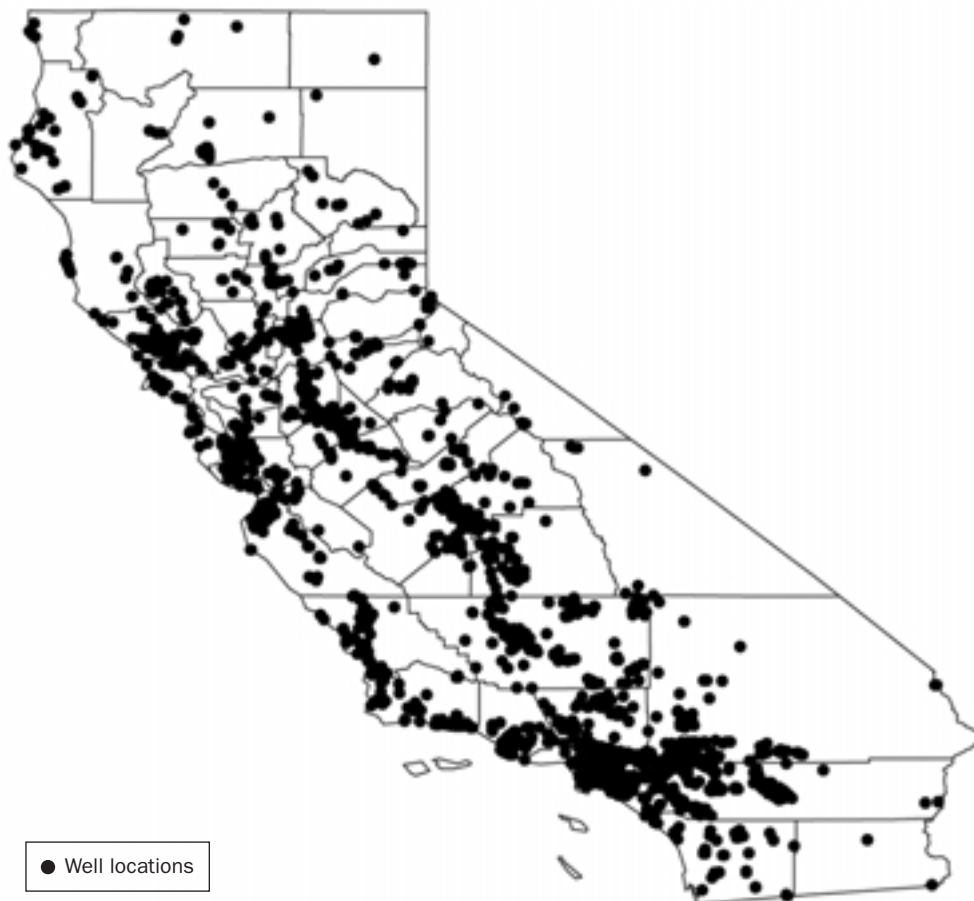
Because the Department’s mandate is limited to public health, its Drinking Water Database not only focuses on drinking water *standards* (as discussed above), but also on drinking water *wells*, omitting a huge portion of California’s groundwater from its coverage. The Department collects information only on active drinking water wells that provide at least 15 service connections or supply a minimum of 25 people

FIGURE 26

Wells Taken Out of Service 1984–2000

More than 4,000 wells have been removed from the drinking water system since the Department of Health Services established its database in 1984.

Source: Data from the Department of Health Services (DHS) Drinking Water Database (1984–2000); compiled by LFR; mapped by NRDC.



for at least 60 days out of the year. The database does not include private wells, which total almost one million in number.²³

Moreover, if a well becomes severely contaminated, it is removed from the drinking water system, and the Department no longer monitors the water quality in that well. Thus, areas of known contamination severe enough to cause a well to be decommissioned are excluded, dramatically skewing the data by eliminating the most contaminated areas from review. More than 4,000 wells²⁴ have been removed from the drinking water system since the database was established, and the coding of those wells in the database implies that contamination may have motivated the closure of many, if not most, of them.²⁵ These decommissioned wells are distributed all over the state, as displayed in Figure 26 (only 92 percent of the decommissioned wells are plotted, as no coordinates were available for the over 300 others).

This combination of limitations renders the Department's Drinking Water database virtually useless as a means of obtaining information about the state of California's

groundwater resources as a whole. One particularly clear example of the incompatibility of the data from the various agencies arises in the case of organics. Figure 14 does not indicate much of a problem with organic compounds in North Coast, Central Coast or the Lahontan Regions, but these are the areas listed as most problematic by the 305(b) Report.

The Department of Pesticide Regulation also maintains a fairly comprehensive database. However, it is not designed to assess anything except pesticides. Furthermore, despite the breadth of its use data, the Department is not able to do comprehensive sampling in all areas or even for all pesticides. Finally, it does not monitor for any pesticides that have been banned.

Groundwater receives somewhat systematic attention in the highly localized areas of the state that have become, or are in the process of becoming, designated cleanup sites. Groundwaters in the vicinity of all funded cleanup sites undergo testing as a matter of policy. However, cleanup site data are not designed to provide a comprehensive assessment of groundwater quality either. The responsible agencies are focused on oversight and/or funding of site remediation.

Moreover, the agencies involved with cleanup sites only look at sites over which they have jurisdiction. Many sites may have been proposed to the state and federal programs but then were discarded or never considered because of some statutory or policy exclusion. In addition, contaminated sites may currently exist that have not been brought to any agency's attention. Finally, the information on groundwater impacts at these sites is not easily accessible. Thus, these data do not provide any perspective on the general quality of the groundwater statewide.

Finally, the U.S. Geological Survey collects reliable data, has a broad, environmental approach that is not focused on specific contaminant thresholds, and maintains a rigorous set of information on all of its samples, including latitudinal and longitudinal coordinate data for all samples. It also has the most extensive data temporally. But the U.S. Geological Survey is not attempting to characterize the whole of California's groundwater resources. It performs localized studies and collects data from other studies conducted by other organizations and agencies to feed into its database. The random origin of these data provide neither a complete nor a representative view of California's groundwater.

Conclusion

In sum, despite the efforts of numerous agencies, the end result of existing monitoring and assessment programs is a collection of data that cannot easily be aggregated and that, even if aggregated, does not provide a complete picture (much less a fully accurate assessment) of the state of the resource. The final chapter of this report discusses the legal system that has contributed to the creation of this ineffective patchwork of monitoring and assessment and provides a set of recommendations for how that system can be improved.

IMPROVING GROUNDWATER ASSESSMENT IN CALIFORNIA



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

The inadequacies that limit the effectiveness of California's monitoring and assessment programs reflect a fragmented regulatory approach that mirrors the state's efforts to prevent groundwater contamination in the first place. If California's assessment programs are housed in a handful of agencies, and if they often reflect narrow focuses, parochial concerns, and a lack of coordination, this approach is a product of an equal or greater number of laws that attempt, often unsuccessfully, to regulate the actual activities that disperse the contaminants and degrade groundwater quality.

Ironically, while this report demonstrates that significant portions of California's groundwater basins are contaminated to differing degrees, most of the state and federal groundwater pollution laws have emphasized prevention. These laws require compliance with a set of processes and standards when engaging in activities that have the potential to release contaminants into the environment. Such a preventative approach is well advised. Assuming that the systems in place could actually prevent releases, this would be the most cost-effective means of protecting groundwater, because, as the State Water Board has recognized, the "cost of prevention usually is significantly less than the cost of treatment or cleanup."¹

Thus, there are regulatory requirements for the handling of hazardous materials and for responding to spills,² as well as for the conduct of certain specific, potentially dangerous operations.³ There are also standards for the transportation⁴ and storage⁵ of hazardous materials, and for the treatment of waste materials prior to their disposal,⁶ as well as for the actual disposal of the waste.⁷

In addition to these regulatory requirements, there are also laws that impose complete prohibitions against an activity or against the use of a certain chemical,⁸ laws requiring a thorough review of the potential impacts of any proposed course of action before it is undertaken,⁹ laws that require the development of a management plan for certain sensitive geographical areas,¹⁰ and laws that restrict funding for activities that may impair groundwater quality.¹¹ Finally, there are laws providing for investigation and remediation of contamination in the event that, despite all of the

TABLE 8**Types of Protection Afforded by Various Federal and State Laws**

This table lists some of the major state and federal laws designed, at least in part, to protect groundwater quality. It is not intended to be a comprehensive list.

Type of Protection	Federal Acts/Requirements	State Acts/Requirements
Prohibition on manufacture and/or use of chemicals	FIFRA and TSCA	Pesticide Contamination Prevention Act
Prohibition on certain processes	Federal Land Policy and Management Act	Adjudication to protect quality of ground water
Standards for materials handling and spill response	Clean Water Act (CWA) Spill Prevention, Control and Countermeasure Plan (SPCCP)	Aboveground Petroleum Tank law SPCCP Program
Standards for how to operate	Safe Drinking Water Act (SDWA); Surface Mining Control and Reclamation Act	Surface Mining and Reclamation Act; Hazardous Waste Reduction, Recycling, and Treatment; Oil and Gas Underground Injection Control (UIC) Wells; Hazardous Substances Underground Storage Take Facility Regulation; Well Standards
Standards for transportation	Hazardous Liquid Pipeline Safety Act and Hazardous Materials Transportation Act	Hazardous Waste Control Act (HWCA)
Standards for storage	RCRA and FIFRA	Aboveground Petroleum Storage and Underground Storage regulations; HWCA
Standards for treatment	CWA and RCRA	HWCA, Porter-Cologne Act (PCA)
Standards for disposal of wastes—siting, operations, etc.	RCRA, Atomic Energy Act, SDWA UIC Program, TSCA (PCB disposal) and Uranium Mill Tailings	HWCA; Toxic Injection Well Control Act; PCA; Toxic Pits Clean Up Act; Oil & Gas UIC Wells
Funding Restrictions	SDWA (sole source aquifers)	
Requirement to develop a Management Plan for an area or a procedure	CZMA, SDWA (wellhead protection), CWA, Federal Land Policy and Management Act	Local Planning; California Coastal Act
Requirement for pre-approval review of potential impacts of proposed actions	National Environmental Protection Act	California Environmental Quality Act
Prohibition on Polluting	SDWA	Proposition 65, PCA
Provisions Investigation	Underground Injection Control (UIC) regulations	Portion-Dolwig Groundwater Basin Protection; Public Water Well Evaluation (AB 1803); SWAT
Provisions for remedy once contamination has occurred	CERCLA (Comprehensive Environmental Response Compensation and Liability Act) and RCRA	PCA Spills, Leaks Investigation & Cleanup (SLIC) Program, Carpenter-Presley-Tanner Hazardous Substances Account Act

above, releases do occur.¹² Table 8 presents the various approaches followed by each statutory scheme.

With all of these regulations, requirements, and prohibitions, one might wonder how so much of California's groundwater came to be contaminated. The unfortunate answer is that, despite the existence of all of these programs, the discussion in Chapters 2 and 3 regarding the contamination in California's groundwater shows

that several, if not most, of the existing programs have been ineffective, inadequate, or both. This is undisputed. When the State Water Board last conducted a thorough review of these programs, in 1987, it concluded that more needed to be done.¹³

One reason the existing regulations have not adequately protected groundwater resources is that there are many holes in the regulatory system. Many sources of contaminants and entire industries are not addressed by any existing laws. Alternatively, laws may ostensibly address these sources, but there is little or no implementation and no enforcement when they are violated. Agricultural practices, for example, have traditionally received less regulation than most of the other major source categories. In some cases this lack of implementation is due to under-funding; in other cases it is due to a lack of political will.

There is also a whole host of pollutants about which we know very little. Nearly 75 percent of “the top high production and volume chemicals have undergone little or no toxicity testing.”¹⁴ Many others have undergone some testing, but not enough for adequate regulation to be imposed. Thus, MCLs exist for only a handful of compounds, despite the fact that EPA estimates that up to 28 percent of all chemicals in its current inventory of about 80,000 have neurotoxic potential.¹⁵ We cannot evaluate the dangers posed by a constituent unless we understand its effects. Similarly, there are also many compounds about which we may or may not know enough to regulate them effectively, but we do not currently monitor for them.¹⁶

In still other cases, although the process and/or the pollutant is currently regulated, it was not always so. In such cases, much of the existing contamination is “legacy” pollution—remnants of an earlier time, when people were not as aware of the dangers posed by their activities and when regulation was less stringent, or non-existent. In those cases, assuming that current practices are effectively preventing additional contamination, the only solution may be remediation of the existing contamination.

Perhaps most fundamentally, as long as the legal systems in place treat California's groundwater as a common pool resource, without any overlying structure to force polluters to internalize the costs of their polluting activities, these activities are likely to continue.

PREVENTION, CONTROL, AND REMEDIATION PROGRAMS

Below is a brief description of some of the major programs, at both the state and federal levels, that are directed specifically at prevention, control, and, if necessary, remediation, of groundwater contamination. This discussion is organized—as are the programs—primarily by the source of the potential contamination. Since the State and Regional Water Boards are the “principal state agencies [within California] with primary responsibility for the coordination and control of water quality,”¹⁷ emphasis is placed on programs run by these agencies. This list is not intended to be comprehensive.

Underground Storage Tanks (USTs)

Generally. Federal regulation of underground storage tanks (USTs) is administered by the U.S. Environmental Protection Agency (EPA) under Title IX of the Solid

Waste Disposal Act.¹⁸ That program includes regulations promulgated by EPA regarding release detection, prevention, and correction, and requiring maintenance of evidence of financial responsibility for UST problems.¹⁹ The program excludes from its purview, among other things, any hazardous waste storage,²⁰ septic systems,²¹ and farm and residential tanks of 1,100 gallons or less that are used for storing motor fuel for noncommercial purposes.²²

At the state level, California has developed a program for preventing and containing underground storage tank leaks that is, in many ways, more stringent than federal regulations.²³ Despite tough regulations, though, California has a difficult time enforcing any standards as a result of the diffuse agency structure established to implement these programs. One hundred and seven (107) Local Implementing Agencies (LIAs) administer and enforce the state UST program, but they do not report to any single agency. Instead they operate under the general oversight of the State Water Board and its nine somewhat autonomous Regional Water Boards.²⁴ An additional shortcoming to the management situation in California is the broad requirement that LIAs physically inspect UST facilities only once every three years.

In 1997, the EPA officially criticized the UST regulatory programs in six states, including California.²⁵ Despite the provisions in the federal act for EPA approval of state programs,²⁶ due to EPA's lack of confidence in California's system, it has not officially approved the state program and continues to share regulatory responsibility with local agencies in a non-systematic manner. Just last year, a study performed by the nonprofit environmental research organization "Environmental Working Group" evaluated 36,000 USTs that had been reported as leaking as far back as 1970. Of this total, only 23,000 cases showed any enforcement information and, of those, over 90 percent were not being cleaned up.²⁷

MTBE. As discussed above, California is planning to phase out its use of MTBE in less than two years. On March 25, 1999, Governor Gray Davis issued Executive Order D-5-99, calling for the removal of MTBE from gasoline "at the earliest possible date, but not later than December 31, 2002."²⁸ California Energy Commission staff have recommended that the deadline not be accelerated, due to technical and legal obstacles involved in making a transition to another form of oxygenates.²⁹

One of those legal obstacles could be overcome if California could obtain a waiver from the Clean Air Act's requirement for oxygenates in California reformulated gasoline. In furtherance of that goal, California applied to EPA for an immediate waiver of that requirement.³⁰ That petition has not yet been resolved, and related legislation appears to be stalled.³¹ Even if EPA does not grant California's requested waiver, though, California will probably convert from MTBE to ethanol (an oxygenate made from corn starch) in 2003, in order to comply with the Executive Order.³²

However, as indicated above, a significant amount of MTBE has already been released into the environment, enough to exceed maximum contaminant levels set by the Department of Health Services in many water bodies throughout the state, and the solution to this problem is now as much one of remediation (discussed below) as it is of prevention and control.

In 1997, in order to better protect drinking water sources from the threat of MTBE contamination, the Legislature passed a law requiring the State Water Board to develop a statewide “geographic information system” (known as “GeoTracker”) to identify the location of every underground fuel tank in the state and to describe whether a release had occurred.³³ Assembly Bill 2886, passed in September of 2000, required the State Water Board to adopt regulations for the electronic submission of the data collected by responsible parties as part of their quarterly monitoring for direct submission to the GeoTracker system. This would allow leaking fuel tank site data to be displayed on the GeoTracker website³⁴ so that those data would be readily accessible to the general public.³⁵

The State Water Board designed the database system that supports GeoTracker to integrate data from the Department of Health Services, as well, and to present the data from the GAMA program (see Chapter 4, note 2). However, despite the integration of these various forms of data, the GeoTracker system—at least in its present form—remains limited. Observers have noted that territorial disagreements within the State Water Board have artificially limited the contamination information in the system to data on leaking underground *fuel* tanks. Data on the release of other substances (such as solvents) from tanks, and on landfills and Superfund sites, which the State Water Board now has in smaller, separate databases that could easily be integrated in GeoTracker, are presently not included in GeoTracker and are not slated for inclusion.

Natural Sources

There is no state system designed to remove natural forms of groundwater pollution on a wholesale basis. To do so would be an enormous undertaking, if it were even possible at all. Instead, to the extent that contaminated groundwater is to be used for human consumption, the Department of Health Services oversees the use of that water to ensure that water purveyors and utilities do not deliver it to end-users in a form that could present a threat to public health.

Agriculture

Agricultural sources of groundwater contamination include the direct application of fertilizers and pesticides, the dispersion of fertilizers and pesticides through agricultural runoff, and the disposal of animal wastes from facilities with highly concentrated animal populations. As a general matter, the Regional Water Boards have authority, under the Porter-Cologne Water Quality Control Act, to regulate the release of any material that may cause impairment to surface or groundwater.³⁶ However, few, if any, Regional Water Boards exercise this control over agricultural applications or runoff.

Pesticide application is also separately regulated by the Department of Pesticide Regulation under the Pesticide Contamination Prevention Act.³⁷ The Department has exercised its authority to ban the use of certain pesticides, but hundreds remain legal, and, as indicated above, both legal and illegal pesticides continue to contaminate large portions of California's groundwater basins.

FIFRA (the Federal Insecticide, Fungicide, and Rodenticide Act) is the federal equivalent of the Pesticide Contamination Protection Act.³⁸ FIFRA requires the testing and registration of all chemicals used as active ingredients of pesticides and pesticide products and requires states and tribes wishing to continue the use of chemicals of concern to prepare a prevention plan targeting specific areas vulnerable to ground-water contamination.³⁹ FIFRA is implemented by the EPA.

Land Disposal and General Waste Management

Land disposal of waste is regulated by federal, state, and local agencies.⁴⁰ At the federal level, it is regulated under the Solid Waste Disposal Act,⁴¹ and implemented by EPA.⁴² Again, EPA has stated that “even the best liner and leachate collection systems will ultimately fail due to natural deterioration.”⁴³ This is not to say that there is no difference between the level of protection provided by different types of facilities, but that we must assume that any facility will eventually fail, and we must be prepared for that. Consequently, solid waste regulation includes everything from improved siting, construction, and operation of disposal facilities, to the implementation of elaborate monitoring systems to provide early notice of any problems so that operators can respond quickly.

Title III of the Solid Waste Disposal Act deals specifically with hazardous wastes.⁴⁴ That title, also known as the Resources Conservation and Recovery Act (RCRA), provides a regulatory framework for managing hazardous waste and for investigating and addressing past and present contamination.⁴⁵

At the state level, both the State Water Board and the California Integrated Waste Management Board, as well as others, have regulations regarding the land disposal of waste products.⁴⁶ The Waste Management Board reviews local solid waste management plans and permit decisions, but primary responsibility for solid waste management lies with local government.⁴⁷ The State Water Board regulations “prescribe siting standards, construction standards, groundwater and vadose monitoring requirements, and closure and post-closure procedures and requirements.”⁴⁸ The transportation, storage, treatment and disposal of hazardous waste is managed primarily by the Department of Toxic Substances Control under the Hazardous Waste Control Act.⁴⁹

Septage

Until recently, California was one of only three states in the nation lacking a uniform statewide regulatory code covering onsite disposal of wastewater.⁵⁰ The Regional Water Boards have authority over such discharges pursuant to their general authority to control any discharges that may impair the state’s waters.⁵¹ In addition, county ordinances generally regulated septic systems.

In September of 2000, the Legislature passed Assembly Bill 885,⁵² directing the State Water Resources Control Board to adopt standards for sewage treatment by January 2004. This legislation authorizes the Regional Water Boards to enforce these standards. The impact of this new system is unlikely to be evident until after disposal requirements have been adopted and implemented.

Industrial Point Sources

The Regional Water Boards have authority to regulate discharges from industrial sources, both under the federal Clean Water Act⁵³ and the Porter-Cologne Water Quality Control Act.⁵⁴ Permits (Waste Discharge Requirements under the state system and NPDES permits under the federal system) are regularly issued for such discharges. The federal government oversees direct underground injection operations through its underground injection control authority, which comes from the Safe Drinking Water Act and RCRA.⁵⁵ This includes prohibitions, characterizations, and inventories.⁵⁶

There are also general operational controls that are designed to reduce the amount of hazardous discharges released from industrial point sources, under programs such as the state's Hazardous Waste Reduction Recycling & Treatment Research & Demonstration Act of 1985 and the Oil & Gas Underground Injection Control Wells Act.⁵⁷

Resource Extraction

At the federal level, the Surface Mining Control & Reclamation Act of 1977 is designed to protect the environment from the impacts of surface mining, but it is focused primarily on coal mining.⁵⁸ The California analogue is the California Surface Mining and Reclamation Act.⁵⁹

Remediation of Existing Contamination and the Funding Thereof

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) established a fund to clean up soil and groundwater contamination, and it authorizes EPA to seek out the responsible parties and assure their cooperation in the cleanup.⁶⁰ However, many people from a wide variety of perspectives have expressed discouragement at the limited progress the program has made over the last 20 years, perhaps in part due to its greater focus on compensation than on remediation. California's CERCLA equivalent is the Carptenter-Presley-Tanner Hazardous Substances Account Act.⁶¹ Both programs are commonly referred to as "Superfund" programs.⁶²

There are other types of mechanisms in place to assist with cleanup projects in other areas. For example, the state Underground Storage Tank Cleanup Trust Fund Act of 1989⁶³ established a system to respond to contamination more rapidly. Some experts claim that this sort of system has been much more effective. A detailed analysis of the funding system and the relative efficacy of the various types of remedial programs would be very useful. However, such an analysis is beyond the scope of this report.

Local and Regional Groundwater Management Programs

In addition to the state and federal programs described above, which are generally tailored to the specific sources they seek to control, there are literally hundreds of regional agencies and municipalities around the state that have adopted their own "comprehensive" groundwater management programs. These programs generally are not linked to any one source of groundwater contamination, and in fact, the programs do not necessarily address water quality at all (though many of them do so).

The structure and effectiveness of [local groundwater management] programs varies widely throughout the state.

The structure and effectiveness of these programs varies widely throughout the state. By law, the Department of Water Resources issues a periodic report listing agencies that have “groundwater management plans that have been adopted either pursuant to . . . the Water Code, or as a result of a court decision.”⁶⁴ As of 1999, DWR reported at least 12 counties that had adopted ordinances relating to groundwater, relying on their police powers.⁶⁵ In addition, there are 23 separate *types* of water management districts authorized by the Water Code with authority to manage groundwater,⁶⁶ and 12 special groundwater management districts or agencies specifically authorized by unique legislative action in each case.⁶⁷

Perhaps the most significant development in the world of local groundwater management, though, was the enactment of Assembly Bill 3030, in 1992,⁶⁸ which allows local agencies to “adopt and implement a groundwater management plan” and to assume certain additional powers by doing so.⁶⁹ In deference to local authority, the law does not apply to basins already subject to management by a local agency or a watermaster, unless the watermaster agrees,⁷⁰ and it does not require any agency to develop a groundwater management plan.⁷¹ DWR reported that at least 156 agencies had taken advantage of this law by 1999.⁷² Here too, though, the contents of the plans vary widely, many have been criticized as dysfunctional, and the system as a whole has been criticized as being an inadequate means of effecting groundwater management.

An assessment of the literally hundreds of local groundwater management plans is beyond the scope of this report. It is clear that local agencies have a major role to play in the management of groundwater resources, and undoubtedly some agencies are doing an excellent job of managing their groundwater basins. However, the focus of this report is on the statewide programs designed to monitor and protect our groundwater resources, and no degree of individualized local action can create a uniform, comprehensive statewide system.

RECOMMENDATIONS

Based on the data and analyses presented above, NRDC concludes that, in order to better understand—and thereby enable ourselves to better manage, restore and protect—California’s vital groundwater resources, the following steps must be taken:

Improve the Scope, Quality, and Accessibility of Information on the State of Our Groundwater Resources

► **Conduct Systematic and Ongoing Monitoring.** At the present time, we have virtually no information on the status of many of our groundwater basins, and the information we do have is often suspect. A single agency should be assigned to collect the existing information from the various agencies that have it and to perform field work to confirm existing estimates and anecdotes. As this body of data becomes more accurate and comprehensive, it will become more useful in managing the waters being monitored, and a specific list of unknowns is likely to emerge. Groundwater

bodies that have never officially been tested, and those for which we have reason to suspect contamination, should then specifically be targeted for further study.

The legislature should require that the State Water Resources Control Board, or another state agency, complete an initial survey of all of the groundwater basins in the state by January 1, 2003. Once that is completed, ongoing, comprehensive, bi-annual tests of all groundwater basins should be conducted regionally, as required by section 305(b) of the Clean Water Act, in order to keep the data current. In areas that appear free of contamination, statistical sampling methods can be used to make this process more efficient, with more extensive sampling occurring where contamination is suspected and/or found.

To the extent that multiple agencies continue to monitor groundwater quality, they should coordinate their roles and share data in order to avoid duplicating efforts. If a coordinated system cannot be adopted expeditiously, serious consideration should be given to completely dismantling and rebuilding the groundwater regulatory system to vest control in a single agency.

► **Standardize and Characterize Data on Groundwater Quality.** The more readily that thorough and accurate information about the status of our groundwater basins becomes available, the more readily that action can be taken (1) to improve the water quality and (2) to protect public health and the environment from the hazards of contaminated groundwater. Groundwater quality data should be standardized to ensure that certain basic information is recorded every time a groundwater sample is examined. Virtually every agency collects some form of useful information that the other agencies do not. The following types of data, which include the essential parameters from each agency's database plus some additional ones, should accompany every sample analyzed: (1) the location (in latitude and longitude) of the sample and the aquifer and depth from which it was taken; (2) the date of the sample; (3) the associated well driller's log; (4) the concentration of all constituents for which the water was analyzed; (5) background levels of those constituents in the area from which the sample was taken, to the extent known; (6) any applicable numerical water quality standards for those constituents, and the uses those standards were designed to safeguard; (7) the detection level associated with each measurement method used; (8) the source of any contaminants found, if known; (9) the source of the data; (10) the data-collection methodology; (11) pumping data for nearby wells.

The formats in which these data are stored should also be standardized, or at least made compatible, so that data from various agencies can be easily combined. The data should be compiled in the upcoming national standard data format for electronic data. The data should be collected in one place, with a single agency in charge. The State Water Board already maintains a database on groundwater quality, so it would seem a natural home for this information. This information could also be stored in an expanded version of the GeoTracker database discussed on page 77.

► **Standardize and Centralize Information on Groundwater Basins.** Presently, the State Water Board, the Department of Health Services, and the Department of Water

Resources all divide up the state, using different regional boundaries. This makes it extremely difficult to compare or compile regional data from multiple agencies. The State Water Board and the Department of Water Resources should work together to develop a uniform system of regional boundaries, based on watersheds. As an alternative, all three sets of boundaries (and any others that exist for groundwater bodies) should be digitized and sent to a single agency to maintain those data in a central database. This would enable that one agency to format any groundwater data to any agency's regional system.

In addition, the Regional Water Boards and the Department of Water Resources do not even share a common system for determining the size of the various groundwater basins that they manage. Although there are legitimate reasons why different agencies would have different perspectives on certain issues, due to their individual charges and expertise, the current system is fundamentally flawed, as it makes it impossible to compare the agencies' data. There should be a single repository of information on the name, size, and location of every groundwater basin and sub-basin within each region of the state. To ensure consistency, all agencies should be required to use that framework as the basis for any assessments of groundwater quality. Because the Department of Water Resources already maintains a database of groundwater basins and is presently updating it, this agency would be the logical choice to coordinate this project.

► **Develop a Better Understanding of Existing Contaminants.** We cannot effectively protect ourselves and our environment unless we understand the potential dangers posed by the various hazards that we encounter. We presently only test our waters for a fraction of the substances that we produce, and we have maximum contaminant levels (MCLs) for an even smaller subset. Further study is needed, and MCLs should be established for many more contaminants than currently have them. Furthermore, determining the relative degree of the threat posed by various types of contaminants allows us to prioritize our efforts and our limited resources to combat those elements that are of greatest concern first. Finally, we should expand the monitoring system discussed in the first bullet to include any compounds discovered, through this process, to be of particular concern. The utility of any monitoring system is inherently limited to the substances that are analyzed within it.

► **Develop a Better Understanding of the Sources of Groundwater Contamination and Their Relative Impacts.** In addition to understanding our groundwater basins and the contaminants within them, we must understand where those contaminants come from, so that we can prevent the problem from exacerbating. We must identify the sources of groundwater contaminants and the waters that are at risk of becoming contaminated, in order to preserve existing water quality. The Source Water Assessment Program is designed for this purpose, but it is being implemented in California in a manner that will be ineffective and wasteful of the resources being expended. Necessary improvements to California's Drinking Water Source Assessment and Protection program include: (1) identifying individual sources rather than only

categories of sources; (2) naming the sources; and (3) improved mapping of the potential threats.

In addition, different sources undoubtedly affect groundwater quality in varying degrees, and resources are wasted if they are spent combating one problem while a much larger problem remains unaddressed. We should use the source data collected in the database discussed above to develop a better understanding of the relative impact of the various sources of groundwater contaminants and prioritize our efforts accordingly. The legislature should require the appropriate regulatory agencies—likely the State Water Board, the Department of Health Services, and the Department of Pesticide Regulation—to report back within two years on the impacts of the various sources of groundwater contaminants. All significant sources must be considered.

► **Make This Information Accessible to the Public Through the Internet.** Compiling the information for this report required an enormous amount of time and resources and the expertise of professionals with many years of experience in environmental law and policy. Information collected by the government on the status of California's natural resources should be readily available to all of the state's residents. The information described above should be provided on a single, easily accessed website, with raw and summary data included in addition to the ultimate judgments of the agencies regarding the significance of the data.

Provide the Necessary Support for These Programs

► **Increase Funding as Necessary to Support the Programs Outlined Above.** There is some evidence that current funding levels for many programs are so low that they do not provide agencies with enough money even to implement the existing, mandatory monitoring systems. Experts in the field have estimated that an effective statewide groundwater assessment and protection program would cost at least \$10 million per year. The funding system should be analyzed to determine if it is sufficient to support existing programs, and funding should be provided both to meet existing responsibilities and to expand existing programs as necessary to accomplish the goals outlined above. As the agencies consider an integrated approach to assessing groundwater quality, funding should be reviewed in conjunction with that assessment.

Minimize the Incidence of Further Contaminating Releases

► **Develop Effective Prevention Systems.** Successful prevention systems are unquestionably the preferred approach over after-the-fact remedial approaches. The legislature should require the appropriate regulatory agencies, likely the State Water Board, the Department of Health Services, and the Department of Pesticide Regulation, to propose improved, coordinated, comprehensive systems to prevent further contamination of our groundwater resources. A system should be developed for each of the primary sources of groundwater contaminants identified, and those systems should be developed in priority order, based on the relative impacts from each of those sources. No significant source should be exempted. Non-point sources, in particular,

must be controlled along with point sources. The programs should include proactive strategies to deal with emerging threats to groundwater.

► **Ensure Effective Implementation and Enforcement of Prevention Programs Developed.**

There are many preventative systems on the books whose efficacies are unknown because they have never been fully implemented. Implementation and enforcement are critical to the functioning of any regulatory system. Particular emphasis should be placed on these aspects in any program that is developed.

Remediate Existing Contamination

► **Ensure Effective Implementation of Remedial Programs.** Although there are systems in place for the remediation of polluted groundwater, again, they are rarely implemented quickly or to their fullest extent. The Environmental Working Group information on the State Water Board's failure to clean up leaking underground tank sites is a perfect example of this problem. Agencies should be required to report to the legislature and to the public annually on the number of releases and contaminated sites of which they are aware and on the steps they have taken to address those situations.

► **Institute "Polluter Pays" Provisions for Groundwater Contamination.** The legislature should pass legislation requiring any party responsible for the release of a contaminant that is considered, by the appropriate agency, to pose a threat to public health or the environment, to pay for the remediation of that situation. However, any necessary remedial action should not be delayed pending the acquisition of any such compensatory payments.

WATER SYSTEMS

The state and federal Safe Drinking Water Acts, and, by extension, the California Department of Health Services (DHS), use an array of specialized terms and phrases to describe water systems of different sizes and types. The primary labels include:

Public Water System:

A drinking water system that either (1) has a minimum of 15 service connections or (2) serves at least 25 people for at least 60 days in a row each year. These are the primary systems over which DHS has jurisdiction under the state's Safe Drinking Water Act. Public Water Systems¹ are categorized as either:

► **Community Water System:** providing at least 15 service connections to yearlong residents OR providing less than 15 service connections to at least 25 year-long residents on a regular basis; or

► **Noncommunity Water System:** public water systems that do not fall under the Community System definition. Noncommunity Water Systems can be further divided:

Nontransient: regularly serves at least 25 of the same people for over six months of the year.

Transient: does not regularly serve at least 25 of the same people for over six months of the year.

State Small Water System:

A drinking water system with between 5 and 14 service connections that does not regularly serve more than 25 individuals for 60 days in a row out of the year (i.e., not a Public Water System). DHS promulgates regulations for the operation of these systems separately from Public Water Systems, and the requirements are generally enforced by local health officials.²

Private Homeowner Wells:

These wells are not officially monitored on any ongoing basis, though a permit process is required initially to drill such a well.³ In addition, local health departments offer free water quality sampling of individual wells.⁴

Another, much less complicated method of categorizing Public Water Systems divides them into two simple categories, as follows:

► **Small water systems:** those with between 5 and 200 service connections.⁵

► **Large water systems:** those with more than 200 service connections.⁶

HUMAN HEALTH-BASED WATER QUALITY STANDARDS

Two California regulatory agencies—the Department of Health Services (DHS) and the Office of Environmental Health Hazard Assessment (OEHHA)—develop water quality standards for the protection of human health against the hazards posed by consumption of contaminated drinking water. The three main standards are



CALIFORNIA'S CONTAMINATED GROUNDWATER

*Is the State
Minding the Store?*

April 2001

maximum contaminant levels (MCLs), public health goals (PHGs), and action levels (ALs). These standards are described below.

Maximum Contaminant Levels (MCLs):

- ▶ An MCL represents the highest concentration of a specific contaminant that is allowed in drinking water under the state and federal Safe Drinking Water Acts.⁷
- ▶ MCLs are based on “risk management” determinations made by the State Department of Health Services (DHS), considering several factors, including detectability, treatability, treatment costs, and health risks. The health risk is determined by DHS estimates or pursuant to OEHHA’s Public Health Goals (PHG).
- ▶ *Primacy MCLs* are set at the level deemed necessary to protect human health. DHS has established primary MCLs for 78 chemical and 6 radioactive contaminants.
- ▶ *Secondary MCLs* are set at the level deemed necessary to protect public welfare and are generally intended to prevent adverse tastes, odors, or appearance in water. DHS has set secondary MCLs for 17 chemicals.

Public Health Goals (PHGs):

- ▶ PHGs represent the concentration levels of contaminants in drinking water that, if not exceeded, should pose no significant health risk when consumed over the course of a lifetime.⁸
- ▶ Unlike MCLs, PHGs are based exclusively on public health considerations.⁹ California’s Office of Environmental Health Hazard Assessment (OEHHA) sets PHGs based on “risk assessment” principles. OEHHA develops a PHG in response to a DHS notice proposing to establish an MCL.
- ▶ PHGs are not enforceable but are used by the Department of Health Services to reassess MCLs, and are provided to consumers and the general public.
- ▶ PHGs are developed for contaminants for which MCLs have been established and contaminants being considered for MCLs. They are reviewed at least once every five years.
- ▶ 59 PHGs exist in California, six of which are in the finalization process. Another 24 contaminants are in line for PHG development.¹⁰

Action Levels (ALs):

- ▶ Similar to PHGs, ALs are health-based, non-enforceable indexes for chemicals in drinking water. Unlike PHGs, ALs are developed by DHS specifically for contaminants that have not yet been assigned MCLs.
- ▶ DHS usually establishes ALs based on previously-conducted studies by governmental agencies. For carcinogens, ALs reflect lifetime cancer risks, while for non-carcinogens ALs reflect adverse health effects.¹¹
- ▶ When an AL is exceeded, a drinking water system must notify local governing agencies and the consumers who receive the water. The water system must suspend service when a contaminant appears at 10 times the AL for non-carcinogens and 100 times the AL for carcinogens.
- ▶ ALs exist for 44 contaminants: 15 have been detected in or near waters supplies, and 29 have been detected rarely, if at all.

ENDNOTES

Executive Summary

1 *Ground Water*, U.S.G.S. General Interest Publication, (Jan. 5, 2001) http://capp.water.usgs.gov/GIP/gw_gip/gw_a.html, 2/27/01.

2 An acre-foot is the amount of water that it takes to cover an acre of land to a depth of one foot. It is equivalent to 325,851 gallons.

3 The current capacity of California's surface water reservoirs is about 43 million acre-feet. *Ground Water Report to Congress*, Ground Water Protection Council, (Oct. 1999), p. 9.

4 *California's Ground Water*, Department of Water Resources Bulletin No. 118, DWR (1975), p. 3 (concluding that groundwater has contributed to the development of the State's economy more than any other resource).

5 In fact, most of the state has a semi-arid climate. *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wild-land Resources (June 1994), p. 1.

6 Of course, water scarcity is not unique to California. Hinrichsen, D., B. Robey, and U.D. Upadhyay, "Solutions for a Water-Short World," Population Reports, Series M, No. 14, Johns Hopkins University School of Public Health, Population Information Program, Baltimore, Maryland, (1998), found that thirty-one countries were facing water stress or water scarcity and predicted that, by the year 2025, "35 percent of the world's projected population of 8 billion people [and 48 countries] will face water shortages." *Water Experts call for Blue Revolution*.

7 State Water Resources Control Board *Strategic Plan* (SWRCB, July, 1997) p. 9; *California's Ground Water*, Department of Water Resources Bulletin No. 118 (DWR, 1975) p. 3 and p. 7. WEF's *Calif. Water Issues Briefing* says 30% (3/10/99) ("WEF web-site") p. 13; see also *California Water Facts Groundwater* p. 1; "Ground Water Report to Congress" (says 40%); also (160-98) pp. 3-48 (30%) "25-40 percent of the state's usable water supply in normal years and up to two-thirds in critically dry years."

8 *California Water Issues* (3/10/99) p.14, <http://www.water-ed.org/california.asp#waterissues>. (update—see chap. 2).

9 *FAQs and Ground Water Facts*, National Ground Water Association (May 20, 1999), www.ngwa.org/gwmarket/faqs.html, 11/17/00.

10 *Ground Water Report to Congress*, Ground Water Protection Council, (Oct. 1999), p. 9.

11 *FAQs and Ground Water Facts*, National Ground Water Association (May 20, 1999), www.ngwa.org/gwmarket/faqs.html, 11/17/00.

12 *Groundwater: The hidden water supply*, California Department of Water Resources, (1997), <http://well.water.ca.gov/gwbrochure/>, 2/27/01, pp. 4-5.

13 *California Water Facts Groundwater*, p. 1.

14 *Groundwater: The hidden water supply*, California Department of Water Resources, p. 3.

15 *California's Ground Water*, p. 3.

16 See, e.g., 2000 *California 305(b) Report on Water Quality*, State Water Resources Control Board (Oct. 2000).

17 These numbers are not necessarily additive, as different classes of contaminants may contaminate the same water body. Thus, it is not necessarily true that 75% of the groundwater in the state (5 x 15%) is impaired.

18 In addition to all the other problems with the data, as indicated above, the results of the State Water Resources Control Board's analysis of the scope of contaminated groundwater in California are present in two-dimensional figures, while groundwater exists in three dimensions.

19 Letter from Stan Martinson, Chief, Division of Water Quality, State Water Resources Control Board, to Janet Hashimoto, U.S. EPA Region IX, Bill Vance, Cal/EPA, and Alex Helprin [sic], NRDC (Mar. 22, 2001). This letter is reproduced in full in the sidebar on page 15 ("Disappearing Data").

Chapter 1

1 *Ground Water*, USGS, p. 1.

2 *Ground Water*, USGS, "How Ground Water Occurs," http://capp.water.usgs.gov/GIP/gw_gip/how_a.html, p. 1; *California Groundwater Management*, p. 2.

3 *California Groundwater Management*, p. 2.

4 *Water Facts No. 6*, p. 2; *Ground Water* (USGS) p. 1; *California's Ground Water* (DWR) p. 1.

5 *California Groundwater Management*, p. 3.

6 *Aquifer Basics*, USGS, <http://capp.water.usgs.gov/aquiferBasics/index.html>, 2/27/01, pp. 2-4; *California's Ground Water*, p. 11.

7 *California Groundwater Management*, p. 3.

8 *Water Facts No. 6*, p. 2; *California Groundwater Management*, p. 2.

9 *Ground Water*, USGS, "How Ground Water Occurs", p. 1-2.

10 *California's Ground Water*, p. 13.

11 *Aquifer Basics*, USGS, p. 2.

12 *California Groundwater Management*, p. 3.

13 *California's Ground Water*, p. 23.

14 See, e.g., Genesis, 29:2 "And [Jacob] he looked, and behold a well in the field, and, lo, there were three flocks of sheep lying by it; for out of that well they watered the flocks: and a great stone was upon the well's mouth. And thither were all the flocks gathered: and they rolled the stone from the well's mouth, and watered the sheep, and put the stone again upon the well's mouth in his place."

15 *The History of Plumbing: Jerusalem*, "From the beginning of Jerusalem's rich history, its lifeline of water depended solely on hidden wells and underground cisterns." <http://www.providence.edu/dwc/pales2.htm>, 2/27/01.

16 *Water & The Shaping of California* 104.

17 *Ground Water Atlas*, Basin and Range Aquifers, p. 8, and Central Valley Aquifer System, pp. 1-2.

18 *California Water*, p. 11.

19 *Ground Water Atlas*, Basin and Range Aquifers, p. 8, and Central Valley Aquifer System, pp. 1-2.

20 *Water & The Shaping of California*, p. 158.

21 *Ground Water Atlas*, Central Valley Aquifer System, p. 2.

22 *Ground Water*, USGS, "How Ground Water Occurs", p. 1; *Water Facts No. 6*, p. 1.

23 *Water Facts No. 6*, pp. 1 and 2.

24 *California's Ground Water*, p. 7.

25 *California's Ground Water*, p. 17.

26 *California's Ground Water*, p. 7.

27 Transpiration is the process whereby plants excrete water, in the form of a vapor, from the surfaces of their leaves. Webster's Dictionary, accessed via <http://m-w.com/cgi-bin/dictionary>, 3/7/01.

28 *Ground Water*, USGS, "How Ground Water Occurs", p. 1.

29 *California's Ground Water*, p. 8.

30 *California Groundwater Management*, p. 10; *California's Ground Water*, p. 8.

31 *Ground Water*, USGS, "How Ground Water Occurs", p. 2.

32 *Water Facts No. 6*, p. 2.

33 *California Groundwater Management*, p. 10.

34 *California's Ground Water*, p. 17.

35 *Water Facts No. 6*, p. 1.

36 See, e.g., *A Comparison of State Groundwater Laws*, K. Patrick and K. Archer, 30 *Tulsa* 123 (Fall, 1994) pp. 147-152 (providing examples of modeling the impacts (1) of proposed groundwater pumping on a nearby surface stream, and (2) of retiring land from irrigation, and thus ceasing irrigation return flows, on groundwater supplies.

37 *Natural Resources Defense Council v. Duvall*, 777 F. Supp. 1533, 1541 (E.D. Cal. 1991) ("surface and ground water . . . are actually an integrated system. . . . Changes made in one part of the system inevitably affect other parts of the system").

38 *Water Facts No. 6*, p. 1.

Chapter 2

1 National Water-Quality Assessment Program, U.S. Geological Survey, USGS's NWQAP data web-site, located at <http://water.usgs.gov/nawqa/data>, Santa Ana Basin, 2/23/01.

2 National Water-Quality Assessment Program, U.S. Geological Survey, USGS's NWQAP data web-site, http://water.wr.usgs.gov/sana_nawqa/, 2/12/01.

3 Phone conversation between Alex Helperin, NRDC, and Julia Huff, USGS, 1/5/01.

4 Such funding, from the federal "Superfund," is authorized under the Comprehensive Environmental Response, Compensation, and Liability Act. See 42 U.S.C. §§ 9601-9675.

5 EPA's CERCLIS database, http://www.epa.gov/enviro/html/cerclis/cerclis_query.html, as reviewed by E. Hester, Levine-Fricke Recon (LFR) (Nov. 20, 2000).

At that time, there were 784 California sites listed in the CERCLIS database, of which 94 were on the National Priorities List ("NPL"). Electronic mail message from E. Hester, LFR, to A. Helperin, NRDC (Nov. 20, 2000, 10:09 a.m.) re "followup on groundwater survey." See note 54 re the Superfund program.

6 Cal. Health & Safety Code § 116325 (providing DHS general responsibility for ensuring implementation of the California Safe Drinking Water Act with respect to "public water systems").

7 <http://www.dhs.cahwnet.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm>, 2/9/2001 (The 1,920 systems collectively serve just over 30 million of the State's 34 million residents, or 89 percent of the population).

8 Figure as of 1987. *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 21.

9 The U.S. Environmental Protection Agency has a similar database (in that it contains compliance information supplied by water providers) called Safe Drinking Water Information System (SDWIS). See http://www.epa.gov/safewater/sdwis_st/state.htm.

10 42 U.S.C. § 300j-12.

11 <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>.

12 The term "pesticide," as used in this report, refers to any chemical used to control a wide variety of pests. It therefore includes not only insecticides and rodenticides, but also herbicides, fungicides, and nematocides.

13 Cal. Food & Agric. Code §§ 13152(a) and 13150.

14 33 U.S.C. § 1315(b).

15 http://wwwdwr.water.ca.gov/dir-general_informationR2/DWR_Overview_History_R2.html, 3/8/01.

16 http://wwwdwr.water.ca.gov/dir-DWR_ProgramsR2/DWR_PGMS-Local_AssistR2.html, 3/9/01.

17 Phone conversation between Alex Helperin, NRDC, and Carl Hauge, Chief Hydrogeologist, Department of Water Resources, 3/10/01.

18 The phrase "purity" is used in this report to refer to the absence of any constituents, whether dissolved or otherwise, in water. In essence, totally pure water would be distilled water, which is 100% H₂O. The terms "impurities" and "contaminants" are used to refer to any constituents within water. This is consistent with the definitions in the state and federal Safe Drinking Water Acts. Cal. Health & Safety Code § 116275(a) (the "term 'contaminant' means any physical, chemical, biological, or radiological substance or matter in water"); 42 U.S.C. § 300f(6) (identical language).

This is not the *only* way in which the term "contaminant" is defined in California law. In fact, some form of the word is defined in at least half a dozen different sections of the California Code, yielding at least four different definitions. Compare Cal. Health & Safety Code § 116275(a) ("any . . . substance or matter in water"), with Cal. Business & Prof. Code § 17577.1(a) and Cal. Health & Safety Code § 116825(d) ("any health-related . . . substance or matter in water"), with Cal. Water Code § 60028 ("any . . . substance, or substances, of a concentration which, if contained in water, will cause a significant impairment to a domestic drinking water supply), with Cal Health & Safety Code § 5410(d) ("an impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease) and Cal. Water Code § 13050(k) (essentially the same language).

19 Again, following the Safe Drinking Water Acts, the term "contaminant" is used herein to mean "any physical, chemical, biological, or radiological substance or matter in water." Cal. Health & Safety Code § 116275(a); 42 U.S.C. § 300f(6).

20 According to the U.S. Geological Survey, as of 1995, over 75 percent of California's groundwater use was for irrigation and livestock (11,034/14,499 = 76.1%), and nearly 20 percent went to public supplies (2,740/14,499 = 18.3%), 95 percent of which went to domestic commercial use

(5,332/5,620 = 94.9%). Thus, given that some groundwater was used directly for domestic use (185/14,499), less than five percent of California's groundwater is used for any purpose other than drinking water and agriculture (11,034 + 2,740x.949 + 185 / 14,499 = 95.3%). *California 1995 Water-Use Water Budget*, W. Templin, U.S. Geological Survey, Sacramento, California, <http://ca.water.usgs.gov/wuse/budget95.html>, 11/21/00.

21 See State Water Board Resolution 88-63 (1988) "Sources of Drinking Water Policy" ("All surface and ground waters of the state are considered to be suitable [for municipal or domestic water supply] and should be so designated by the Regional Boards," with a limited number of enumerated exceptions).

22 *A Briefing on California Water Issues*, Edited by Rita Schmidt Sudman, Executive Director, Water Education, (November 2000) <http://www.water-ed.org/california.asp#waterissues>, 3/6/01.

23 *Strategic Plan*, State Water Board, (July 1997) p. 10.

24 *Ground Water Report to Congress*, Ground Water Protection Council, (Oct. 1999), p. 9.

25 *Id.*

26 *San Francisco Bay Region 2 Basin Plan*, California Regional Water Quality Control Board, p. 4-52.

27 33 U.S.C. § 1313(c).

28 Cal. Water Code §§ 13050(f) and 13142.

29 33 U.S.C. § 1315(b).

30 1998 305(b) Report, p. 169.

31 *2000 California 305(b) Report on Water Quality*, State Water Resources Control Board (Oct. 2000).

32 *2000 California 305(b) Report on Water Quality*, p. 320.

33 *2000 California 305(b) Report on Water Quality*, State Water Resources Control Board (Oct. 2000), p. 320, Table 4D.

34 The impaired/threatened distinction is not clearly maintained. Each Regional Water Board decides independently how it will treat each water body, and some may have coded threatened water-bodies as being "caused by" one of these contaminants. Phone conversation between Alex Helperin,

NRDC, and Nancy Richard, Environmental Specialist and 305(b) Coordinator, State Water Resources Control Board (Mar. 9, 2001). Given the fact that the threatened waters comprise only about 10 percent of the area covered by the impaired waters, and not all threatened waters are included in these summary figures, the inclusion of some threatened waters is unlikely to make a significant difference.

35 33 U.S.C. § 1251.

36 33 U.S.C. § 1362(14).

37 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 3. Three reasons listed: (1) 50% of California's usable groundwater is beneath the Central Valley, where non-point pollution from agricultural activities and septic tanks are common; (2) awareness of non-point source threat is more recent; and (3) most activities that result in non-point contamination still occur, while most point sources have been identified and eliminated, p. 3 and 13 (for the last clause). Thus, they concluded, our ability to control groundwater degradation depends on our ability to control non-point source pollution, p. 13.

38 Phone conversation between Alex Helperin, NRDC, and David Spath, Division Chief, Drinking Water Program, Division of Drinking Water and Environmental Management, California Department of Health Services, 12/26/2000.

39 22 C.C.R. §§ 64400.10 and 64400.80.

40 Phone conversation between Dvora Inwood and Rick Rhoda, Sanitary Engineer Associate, Division of Drinking Water and Environmental Management, Department of Health Services, 1/22/01.

41 The data actually covered the period October 1, 1999, to September 30, 2000.

42 The data revealed 6,553 examples of exceedances out of 601,541 samples, which equals 1.1%. See Glossary for more complete explanation of MCLS.

43 Another 697 exceedances lacked coordinate data, and thus, could not be plotted.

44 California Code of Regulations, Title 22, Division 4 (Environmental Health), Chapter 15 (Domestic Water Quality & Monitoring), sections 64400 *et seq.*

45 See Glossary section on Human Health-Based Water Quality Standards.

46 Phone conversation between Alex Helperin, NRDC, and David Spath, Division Chief, Division of Drinking Water and Environmental Management, California Department of Health Services (Mar. 9, 2001).

47 *Safe Drinking Water Act*, Federal EPA 1996 Amendments, SEC. 132. SOURCE WATER ASSESSMENT, requires states to implement a source assessment program, <http://www.epa.gov/safewater/sdwa/text.html>, 2/27/01.

48 DHS decided to focus on potentially contaminating activities, rather than on contaminants themselves, because of the lack of available data on contaminants. Phone conversation between Alex Helperin, NRDC, and Marguerite Young, 1/26/01.

49 <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>, 12/29/00.

50 <http://www.dhs.ca.gov/ps/ddwem/dwsap/assessments.htm>, 1/31/01.

51 <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>, 12/29/00.

52 *Introduction to the HRS (Hazard Ranking System)*, U.S. Environmental Protection Agency, (Aug. 27, 1999), http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm, 2/9/01.

53 "Ground water contamination is a common item in today's news. Huge sums of money are being spent to clean up contamination once it has occurred. Experience gained in these cleanup attempts has taught us some valuable lessons. Remediation (cleanup) of a contaminated aquifer is costly and often difficult, if not impossible, to achieve." *Fundamentals of Groundwater Contamination*, By Professor Darryll T. Pederson, Hydrogeologist, University of Nebraska, Lincoln, <http://nesen.unl.edu/csd/illustrations/ec11/ec11text.html>, 2/9/01.

54 The "Superfund" program is a function of the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 6921-39b.

55 See note 5.

56 Improving Site Assessment: pre-CERCLIS Screening Assessments, EPA-540-F-98-039, OSWER 9375.2-11FS, PB98-963310 (EPA, Oct. 1999).

57 42 U.S.C. §§ 6921 -39b. *Improving Site Assessment: pre-CERCLIS Screening Assessments*, EPA-540-F-98-039, OSWER 9375.2-11FS, PB98-963310 (EPA, Oct. 1999); for more information on the Resource Conservation and Recovery Act, see <http://www.epa.gov/epaoswer/hazwaste/data/ei.htm>.

58 Official Superfund and CERCLIS literature, EPA, <http://www.epa.gov/superfund/index.htm>, 2/9/01.

59 EPA web-page entitled "Inventory of CERCLIS and Archive (NFRAP) Sites by State as of January 22, 2001," <http://www.epa.gov/superfund/sites/topics/archinv.htm>, 2/4/01. As of December 27, 2000, this page listed 1049 CERCLIS sites in California, but two other EPA web-sites (http://www.epa.gov/enviro/html/cerclis/cerclis_query.html and <http://www.epa.gov/superfund/sites/query/basic.htm>) indicated that there were between 780 and 790 sites in California. NRDC inquired of EPA regarding this discrepancy, and EPA reduced the number listed in the first site from 1049 to 787 without providing any explanation for the prior disparity.

60 NPL site locations taken from http://www.epa.gov/enviro/html/cerclis/cerclis_query.html. Drinking water supply sites are from the EPA's BASINS database and are significantly fewer than the number reported by the California Department of Health Services.

61 *CalSites Database Status Definitions*, received from B. McIntosh, Department of Toxic Substances Control, Site Mitigation Program (Dec. 21, 2000), p. 1.

62 *Id.*, p. 4.

63 *Id.*, p. 3.

Chapter 3

1 *The Rime of the Ancient Mariner*, Samuel Taylor Coleridge (1772-1834), lines 122-23.

2 *Ground Water Atlas*, Central Valley Aquifer System, p. 10.

3 *Ground Water Atlas*, Central Valley Aquifer System, p. 10.

4 See Glossary section on Human Health-Based Water Quality Standards.

5 According to extensive studies performed by the Western Australian farming government agency, different crops become affected by salinity at different levels. Sensitive plants such as strawberries, raspberries, carrots and beans show crop loss at about 500 mg/L. Other, sturdier crops, such as broccoli, squash and olives become impacted at 1375 mg/L, and beets generally do not show crop loss until 1,870 mg/L. *Water salinity and crop irrigation*, Agriculture Western Australia, Farmnote, By Neil Lantzke, Development Officer and Tim Calder, Technical Officer <http://www.agric.wa.gov.au/agency/Pubns/farmnote/1999/f04699.htm#table1a>.

6 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 20.

7 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 21.

8 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 21.

9 See Chapter 2, note 18.

10 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 20.

11 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 21.

12 *Ground Water Atlas*, Central Valley Aquifer System, p. 10.

13 Todd, David K. (1980). *Groundwater Hydrology*, 332, pp. 494-5.

14 See note 22.

15 *Environment, Infrastructure and Water Committee: Reducing Salinity in California's Water Supply*, March 2, 2000, Prepared by Jacques McMillan, EIW Committee, <http://www.vica.com/VICAPositions/2000/0003salinity.html>, 2/13/01; see also *Metropolitan Joins Energy Secretary Richardson in Effort to Protect Water Source for 17 Million Southern Californians* (Feb. 11, 2000), Press Release from MWD, <http://www.mwd.dst.ca.us/Docs/BreakingNews/PressReleases/2000-02/00abmou.htm>, 3/5/01 ("For every 100 milligrams of salt per liter in the region's water supply, the region incurs \$100 million in direct and incidental costs and impacts Southern California's many water recycling efforts.").

16 *Id.*

17 *Id.*

18 USGS actually analyzed its samples for specific conductance, in units of microsiemens per centimeter at 25°C (µS/cm @ 25°C), rather than for salinity. NRDC used a conversion factor of .65 to translate these units into milligrams per liter (mg/L) of total dissolved solids. Thus, 1,000 µS/cm @ 25° C would become 650 mg/L of total dissolved solids (1,000 x .65). This conversion factor was recommended by a representative of the U.S. Geological Survey (USGS). Phone conversation between Alex Helperin, NRDC, and Roy Schroeder, USGS, 2/5/01.

19 The counties for which data were not assessed were: Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Inyo, Lassen, Mendocino, Modoc, Mono, Nevada, Placer, San Benito, San Francisco, Santa Clara, Sierra, Siskiyou, Trinity, Tuolumne, Yuba. Most of these counties were excluded because they contain very little groundwater. In fact, approximately 60,000 of the 70,000 (85.7%) sites in the USGS database for California are located in the counties for which data was requested. Phone conversation between Alex Helperin, NRDC, and Julia Huff, USGS, 1/5/01.

- 20 Counties in which there were fewer than 50 samples taken and analyzed for specific conductance over the ten-year period were considered to present insufficient data. The number of samples taken in the counties that are represented ranged from 61 to 3,350.
- 21 40 C.F.R. § 143.3 (secondary standard); *Current Drinking Water Standards*, EPA Office of Water, www.epa.gov/safewater/mcl.html, 3/6/2001. Like EPA, California also has only a secondary maximum contaminant level for total dissolved solids. It lists both a recommended MCL (500 mg/L), and an upper MCL (1,000 mg/L). 22 C.C.R. § 64449.
- 22 *The California Water Plan Update, Bulletin 160-98*, State of California, Department of Water Resources. (1998), 7-61.
- 23 *Ground Water Atlas*, Central Valley Aquifer System, p. 10.
- 24 <http://www.epa.gov/iaq/voc.html>.
- 25 Government report on the lower Illinois River Basin as part of the USGS 1991 National Water Quality Assessment program, <http://www-il.usgs.gov/proj/lirb/pubs/voc/voc.html>, 2/9/01.
- 26 Assembly Bill 1803 (1983); former Cal. Health & Safety Code § 4026.2 (repealed).
- 27 "Organic Chemical Contamination of Large Public Water Systems in California," DHS (Apr. 1986), pp. ii.
- 28 Phone conversation between Alex Helperin, NRDC, and Bill Ray, Chemist, State Water Board, 2/2/01.
- 29 "Action levels" are non-enforceable advisory levels set by the Department of Health Services for contaminants that lack primary MCLs, in order to provide "an adequate margin of safety to prevent potential risks to human health." Cal. Health & Safety Code § 116455(c)(1); *MCLs, Action Levels, and Unregulated Chemicals Requiring Monitoring*, California Department of Health Services, (Oct. 2, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/MCL/mclindex.htm, 11/8/00. See also www.dhs.ca.gov/ps/ddwem/chemicals/AL/actionlevels.htm. Again, the wells that were sampled were those believed to be the most likely to be contaminated. "Organic Chemical Contamination of Large Public Water Systems in California," DHS (Apr. 1986), pp. ii and 132.
- 30 "Organic Chemical Contamination of Large Public Water Systems in California," DHS (Apr. 1986), p. 132.
- 31 "Organic Chemical Contamination of Large Public Water Systems in California," DHS (Apr. 1986), p. 134. See note 29 re "action levels."
- 32 *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 20.
- 33 *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 20. See note 29 re "action levels."
- 34 *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 21.
- 35 Phone conversation between Alex Helperin, NRDC, and Rick Rhoda, Sanitary Engineer Associate, Division of Drinking Water and Environmental Management, California Department of Health Services, 12/20/2000; phone conversation between Alex Helperin, NRDC, and David Spath, Division Chief, Drinking Water Program, Division of Drinking Water and Environmental Management, California Department of Health Services, 12/26/2000.
- 36 Again, this is based on over 600,000 tests (though many of them not testing for organics) on about 7,100 different groundwater sources.
- 37 The map in Figure 14 reflects almost 8,000 sites, and over 92 percent of the sites where organics were detected. The other 660 sites did not have corresponding coordinate data in the Drinking Water Database, so they could not be plotted. Most of the other sites, however, were in Los Angeles and San Bernardino counties.
- 38 Several thousand "together," according to the DWSAP Program Summary web-page.
- 39 *Central Valley Regional Board Basin Plan*, pp. IV-5.00.
- 40 Lynton Baker, Renee Capouya, Carole Cenci, Renaldo Crooks, and Roland Hwang, THE LANDFILL TESTING PROGRAM: DATA ANALYSIS AND EVALUATION GUIDELINES (Sacramento, Calif.: California Air Resources Board. 41 <http://www.epa.gov/safewater/mtbe.html>, 2/1/01.
- 42 MTBE is discussed separately from other VOCs because of its unique and timely salience in California's struggle to protect its groundwater resources.
- 43 *Environmental Science & Technology News*, http://pubs.acs.org/hotartcl/est/2000/research/0666-00may_pankow.pdf (May 1, 2000), 1/29/01.
- 44 *Treatment Technologies for Removal of Methyl Tertiary Butyl Ether (MTBE) from Drinking Water*, The California MTBE Research Partnership, Center for Groundwater Restoration and Protection, Fountain Valley (1999); *Clean ethanol may replace MTBE in fuel*, John Howard, Associated Press, *Contra Costa Times* (Nov. 17, 2000).
- 45 *Treatment Technologies for Removal of Methyl Tertiary Butyl Ether (MTBE) from Drinking Water*, By The California MTBE Research Partnership, (1999). Center for Groundwater Restoration and Protection, Fountain Valley.
- 46 *Health & Environmental Assessment of MTBE; Report to the Governor and Legislature of the State of California as Sponsored by SB 521*, Vol. I (Summary & Recommendations), by A. Keller, J. Froines, C. Koshland, J. Reuteer, I. Suffet, and J. Last, UC (November 12, 1998), Summary, p. 15, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 47 Draft Staff Findings: *Timetable for the Phaseout of MTBE from California's Gasoline Supply*, G. Shrempp, California Energy Comm'n, Docket No. 99-GEO-1 (June 1999), p. 4.
- 48 *Health & Environmental Assessment of MTBE* (see note 54); Vol. I, p. 12, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 49 *Health & Environmental Assessment of MTBE* (see note 54), p. 15, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 50 *MTBE in the Nation's Ground Water*, By P. Squillace, U.S. Geological Survey, National Water-Quality Assessment Program Results, <http://sd.water.usgs.gov/nawqa/vocns/brp-pjs-handout.html>, 2/12/01.
- 51 "MTBE in Michigan's Backyard," By Mike Tolinski, *From the Ground Up*, Ecology Center, (Aug./Sept. 2000), <http://www.ecocenter.org/aug00/mtbeaug00.html>, 2/7/01.
- 52 California State Auditor/Bureau of State Audits Summary of Report Number 98112 (Dec. 1998), "California's Drinking Water: State and Local Agencies Need to Provide Leadership to Address Contamination of Groundwater by Gasoline Components and Additives," <http://www.bsa.ca.gov/bsa/summaries/98112sum.html>, 3/13/01.
- 53 "Final Statement of Reasons, Primary Maximum Contaminant Level for MTBE," Title 22, California Code of Regulations. (Feb. 2000). <http://www.dhs.ca.gov/ps/ddwem/publications/Regulations/4-17-00MTBESOR.PDF>, 2/27/01.
- 54 *Health & Environmental Assessment of MTBE; Report to the Governor and Legislature of the State of California as Sponsored by SB 521*, Vol. IV (Ground and Surface Water), Chapter 1 (Impacts of MTBE on California Groundwater), by G. Fogg, M. Meays, J. Trask, C. Green, Eric LaBolle, T. Shenk, and D. Rolston, UC Davis, p. 14, and Chapter 2 (Leaking Underground Storage Tanks (USTs) as Point Sources of MTBE to Groundwater and Related MTBE-UST Compatibility Issues), <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00 (the source of most incidences is unknown, but the largest known source is tanks, and they are at least a significant source).
- 55 *Health & Environmental Assessment of MTBE* (see note 54), p. 11, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 56 Senate Bill 521.
- 57 *Health & Environmental Assessment of MTBE* (see note 54), p. 11, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 58 Executive Order D-5-99 issued by Governor Gray Davis on the 25th of March 1999, <http://www.calepa.ca.gov/programs/MTBE/EOTasks.htm>.
- 59 22 C.C.R. §§ 64444 (primary) and 64449 (secondary).
- 60 ACWA web-site, <http://www.acwanet.com/legislation/regulatory/mtbepacket.html>.
- 61 ACWA web-site, <http://www.acwanet.com/legislation/regulatory/mtbepacket.html>; *Uncontrolled LUSTs*, Z. Ross and B. Walker, Environmental Working Group (July, 2000), p. 2.

- 62 *Health & Environmental Assessment of MTBE*, Vol. IV, Chapter 1 (see note 54), p. 23, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 63 *Uncontrolled LUSTs*, Z. Ross and B. Walker, Environmental Working Group (July 2000), p. 21 (Table 8).
- 64 *Health & Environmental Assessment of MTBE*, Vol. IV, Chapter 1 (see note 54), p. 18, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 65 *MTBE in California Drinking Water*, California Department of Health Services (Jan. 25, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm, 2/1/01. This information comes from the regular and ongoing testing required of water suppliers, and it is considered to be comprehensive. Phone conversation between D. Inwood and Steve Book, Research Scientist and Staff Toxicologist at Department of Health Services Drinking Water Technical Programs. MTBE is considered detected if it is found to be present at or above 0.5 µg/L in at least two samples from a source. See also *Health & Environmental Assessment of MTBE*, Vol. IV, Chapter 1 (see note 54), p. 35, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 66 *MTBE in California Drinking Water*, DHS (Nov. 8, 2000), <http://www.dhs.ca.gov/ps/ddwem/chemicals/mtbe/mtbeindex.htm>, 11/17/00.
- 67 *MTBE in California Drinking Water*, California Department of Health Services (Jan. 25, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm, 2/1/01. MTBE is considered detected if it is found to be present at or above 0.5 µg/L in at least two samples from a source; *Health & Environmental Assessment of MTBE*, Vol. IV, Chapter 1 (see note 54), p. 35, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 68 *MTBE in Drinking Water: Ground Water Sources*, Department of Health Services web-site (Jan. 3, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/mtbe/groundwater.htm, 2/1/01.
- 69 Zip code data indicates 5 hits in zip code 95108, which the postal services web site says is in San Jose. http://www.usps.gov/nscs/lookups/lookup_ctystzip.html, 1/12/01.
- 70 *A Briefing on California Water Issues*, "Groundwater Overdraft and Contamination," Water Education Foundation, By Josh Newcom (Nov. 2000), p. 14, <http://www.water-ed.org/california.asp#waterissues>, 3/1/01.
- 71 ACWA web-site, <http://www.acwanet.com/legislation/regulatory/mtbepacket.html>.
- 72 *Id.*
- 73 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994) p. 17, citing DWR's *Preliminary Report: Draft Water Quality Assessment Summary Report; Water Quality Concerns* (Apr. 1991).
- 74 *America's Animal Factories: How States Fail to Prevent Pollution from Livestock Waste*, Robbin Marks and Rebecca Knuffke (NRDC, Dec. 1998), Chapter 1.
- 75 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 18.
- 76 *Id.*
- 77 *Pollution From Feedlots Threatens Our Nation's Waters*, Clean Water Network web-site, www.cwn.org/docs/facts/feedlot.htm, 10/31/00.
- 78 *Water Quality Control Plan, Los Angeles Region—Strategic Planning and Implementation* (June 13, 1994) p. 4-46.
- 79 *Ground Water Atlas*, Central Valley Aquifer System, p. 11.
- 80 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 17.
- 81 22 C.C.R. § 64431(a).
- 82 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 17.
- 83 *Los Angeles Regional Water Quality Control Board Basin Plan* (1994), p. 4-59.
- 84 *Central Coast Basin Plan*, p. IV-15.
- 85 *Lohantan Regional Board Basin Plan*, pp. 5.7-12 to 13.
- 86 *Ground Water Report to Congress*, Ground Water Protection Council (Oct. 1999), p. 9; *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 17.
- 87 *Ground Water Atlas*, Central Valley Aquifer System, p. 11.
- 88 Phone Conversation between Alex Helperin, NRDC, and Anthony Saracino, 10/26/00.
- 89 *MTBE found in deep aquifer*, Orange County Register (Oct. 26, 2000).
- 90 *Ground Water Atlas*, Central Valley Aquifer System, p. 10.
- 91 The nitrogen data presented here are in the form of nitrate (NO_3^{-1}) plus nitrite (NO_2^{-1}), expressed as nitrogen, dissolved.
- 92 Counties in which there were fewer than 50 samples analyzed for nitrate (NO_3^{-1}) plus nitrite (NO_2^{-1}) over the ten-year period were considered to present insufficient data. The number of samples taken in the counties that are represented ranged from 51 to 2,010.
- 93 Natural breaks is a data classification method used to enable patterns to emerge from a data set. Statistical summary information inherently results in the loss of some data. Based on NRDC's professional judgment, it was determined that the information in this data set that would be lost using alternative methods of data classification (e.g., equal intervals or equal areas) would obscure the natural spatial patterns present in the results. Thus, natural breaks were used to ensure that the actual distributions emerged. This map was generated using ArcView version 3.2a. This mapping program identifies significant gaps in the data and creates boundaries based upon these gaps. This minimizes bias in the data.
- 94 EPA's *Ground Water Report to Congress*, p. 9.
- 95 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), pp. 18-20.
- 96 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 18.
- 97 Again, these nitrate data are presented in terms of nitrate (NO_3^{-1}) plus nitrite (NO_2^{-1}), expressed as nitrogen, dissolved.
- 98 *Effect of Agriculture on Ground Water, Eastern San Joaquin Valley*, USGS Circular 1159 (April 1998), <http://water.usgs.gov/pubs/circ1159/sec6.html>, 3/19/01.
- 99 The term "pesticide," as used in this report, refers to any chemical used to control a wide variety of pests. It therefore includes not only insecticides and rodenticides, but also herbicides, fungicides, and nematocides.
- 100 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 10.
- 101 1,2-dibromo-3-chloropropane (DBCP), for example, was banned almost a quarter century ago, yet it continues to be one of the largest, if not the largest, pesticide problems in California groundwater. *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 14.
- 102 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 10, citing Jack Barbash and Elizabeth Resek, *Pesticides in Ground Water: Distribution, Trends, and Governing Factors* (Chelsea, MI: Ann Arbor Press, 1996), p. 153.
- 103 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 24.
- 104 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, California Public Interest Research Group [CalPIRG] (1999), p. 21, citing National Academy of Science four-year study dated July 1999.
- 105 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG, (1999), p. 19, citing DPR Information Systems Branch, 1997.
- 106 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 17.
- 107 California Food and Agriculture Code, section 13152(a) and (e).

- 108 *Sampling for Pesticide Residues in California Well Water*, (Cal/EPA, DPR, Dec. 1999), p. 5.
- 109 They tested for between 1 and 72 pesticides, depending on the county. *Sampling for Pesticide Residues in California Well Water*, (Cal/EPA, DPR, December 1999), pp. 4-5 and 9-10 (Table I-5).
- 110 *Id.*, pp. 9-10 (Table I-5).
- 111 *Id.*, pp. 16-18 (Table I-7). Six of these ten also had no water quality criterion.
- 112 These include DBCP, Simazine, Diuron, ACET, Atrazine, Bromacil, EDB, Deethyl atrazine, 1,2-Dichloropropane, TPA, DACT, Prometon, Bentazon, Methyl bromide, Aldicarb sulfoxide, Aldicarb sulfone, Norflurazon, and Carbon disulfide. *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 11. Heptachlor has also been found in nine different wells and Chlorthal in eight. *Id.*
- 113 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), p. 12.
- 114 *Id.*
- 115 *Pesticides in Ground Water*, USGS Fact Sheet FS-244-95 (National Water Quality Assessment Pesticide National Synthesis Project), "Pesticides Found in Ground Water." URL: water.wr.usgs.gov/pnsp/gw/9/19/00.
- 116 *Pesticides in Ground Water*, USGS Fact Sheet FS-244-95 (National Water Quality Assessment Pesticide National Synthesis Project), "Highlights." URL: water.wr.usgs.gov/pnsp/gw/9/19/00.
- 117 DPR itself cautions against viewing one year of data as signifying a trend. *Pesticide Use Analysis and Trends from 1991 to 1996*, by L. Wilhoit *et al.*, DPR (May 1999), p. 1.
- 118 *Summary of Pesticide Use Report Data 1999*, DPR (Sept. 2000) § III ("Data Summary"). Averages were calculated in millions of pounds, figured to four significant figures: $204.9 - 176.0 / 176.0 = 16.4\%$.
- 119 *Id.*
- 120 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 26.
- 121 *Summary of Pesticide Use Report Data 1999*, DPR (Sept. 2000) § IV ("Trends in Use . . .").
- 122 *Pesticide Use Analysis and Trends from 1991 to 1996*, L. Wilhoit *et al.*, DPR (May 1999), p. 7.
- 123 *Id.*, Table 1 and Figure 2. It also notes that "only a few of the pesticides and crops with the largest increases are discussed."
- 124 Phone conversation between Alex Helperin, NRDC, and Gina Solomon, NRDC, 2/12/01. Methyl bromide is also an ozone depleter and is therefore slated to be banned nationally under the Montreal protocol.
- 125 <http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/copper-sulfate-ext.html>, 2/12/01.
- 126 *Summary of Pesticide Use Report Data 1999*, DPR (Sept. 2000) § IV ("Trends in Use . . ."), Tables 3A ($34.3 - 30.25 / 30.25 = 13\%$) and 4A ($27.2 - 20.2 / 27.2 = 26\%$).
- 127 *Ground Water Atlas*, Central Valley Aquifer System, p. 11.
- 128 *Toxics on Tap*, By Brad Heavner, CalPIRG, (1999), p. 12.
- 129 *Ground Water Atlas*, Central Valley Aquifer System, p. 11.
- 130 *Effect of Agriculture on Ground Water, Eastern San Joaquin Valley*, USGS Circular 1159 (April 1998), <http://water.usgs.gov/pubs/circ1159/sec6.html>, 3/19/01.
- 131 Slutsky, M., Levin, J.L., Levy, B.S. *Azoospermia and Oligospermia Among a Large Cohort of DBCP Applicators in 12 Countries*. *International Journal of Occupational and Environmental Health*, 1999; 5:116-122.
- 132 *Ground Water Atlas*, Central Valley Aquifer System, p. 11.
- 133 *Ground Water Atlas*, Central Valley Aquifer System, p. 11. *Toxics on Tap*, By Brad Heavner, CalPIRG, p. 17, states that DBCP use was suspended by the California Department of Food and Agriculture in 1977, then banned completely by the U.S. EPA in 1979.
- 134 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 26.
- 135 *Id.*, p. 26.
- 136 See note 29 re "action levels."
- 137 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 26; *DHS Review of DBCP's Maximum Contaminant Level*, www.dhs.ca.gov/ps/ddwem/chemicals/DBCP/DBCPindex.htm, 2/5/01.
- 138 Compare Office of Environmental Health Hazard Assessment Public Health Goal (0.0017 parts per billion), <http://www.oehha.ca.gov/water/phg/allphgs.html>, 11/22/2000, with Department of Health Services Maximum Contaminant Level (0.0002 parts per million = 0.2 parts per billion), <http://www.dhs.ca.gov/ps/ddwem/cdchemicals/mcl/primarymcls/htm>, 12/11/2000.
- 139 *Effect of Agriculture on Ground Water, Eastern San Joaquin Valley*, USGS Circular 1159 (April 1998), <http://water.usgs.gov/pubs/circ1159/sec6.html>, 3/19/01.
- 140 *Toxics on Tap: Pesticides in California Drinking Water Sources*, By Brad Heavner, CalPIRG (Californians for Pesticide Reform, 1999), pp. 17-18.
- 141 Lead is also of concern, but it is more a product of pipes used to convey the water to end-users than it is a concern within ground-water basins.
- 142 Phone conversations with Gina Solomon on 10/30/00 and 11/7/00.
- 143 *Arsenic Occurrence and Conjunctive Management in California*, Saracino-Kirby, Inc. (September 2000), p. 2, citing (Welch, 2000).
- 144 *Arsenic and Old Laws*, NRDC, (2000).
- 145 *State: Drinking Water Standards*, www.dhs.ca.gov/ps/ddwem/chemicals/mcl/primarymcls.htm (May 23, 2000), 12/11/00. 66 FR 6976, January 22, 2001 changes the arsenic MCL from 50 µg/L to 10 µg/L.
- 146 *Arsenic and Old Laws*, NRDC, (2000), Table 2.
- 147 *Id.*, Table 1.
- 148 The composite database included data from USGS, DHS, DWR, and USBR, among others. *Arsenic Occurrence and Conjunctive Management in California*, Saracino-Kirby, Inc. (Sept. 2000), p. 5.
- 149 *Id.*, pp. 6-8.
- 150 Standard risk assessment procedures assume the consumption of two liters of water per day, for 70 years. *Arsenic and Old Laws*, NRDC (2000), Table 2.
- 151 *Arsenic Occurrence and Conjunctive Management in California*, Saracino-Kirby, Inc. (Sept. 2000), p. 13 (Figure 6).
- 152 *Arsenic and Old Laws*, NRDC (2000), Table 2.
- 153 *Trouble on Tap*, NRDC (Oct. 1995), Table 1A: Arsenic—National Occurrence Data.
- 154 *Chromium-6 in Drinking Water*, California Department of Health Services (Feb. 5, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/chromium6/cr+6index.htm, visited Feb. 5, 2001; *State of Reviews of MCLs for 13 Contaminants*, Department of Health Services (September 19, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/phgs/reviewstatus.htm (11/8/2000), p. 3; *Chromium and Compounds*, p. 1.
- 155 *Hexavalent Chromium . . . in Drinking Water*, p. 1; *Chromium and Compounds*, p. 1.
- 156 The fact that it is "oxidized," from a chemical standpoint, simply means that the element has gone to a more positive valence.
- 157 *Chromium and Chromium Compounds*, EPA, <http://www.epa.gov/ttn/uatw/hlthef/chromium.html>, 3/13/01; *State of Reviews of MCLs for 13 Contaminants*, Department of Health Services (September 19, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/phgs/reviewstatus.htm (11/8/2000), p. 3.
- 158 *Toxicological Review of Hexavalent Chromium*, in *Support of Summary Information on the Integrated Risk Information System (IRIS)*, US EPA, 1998b, (Aug. 1998), states that: "Results of occupational epidemiologic studies of chromium-exposed workers across investigators and study populations consistently demonstrate that chromium [hexavalent] is carcinogenic by the inhalation route of exposure."

- 159 Hexavalent Chromium . . . in *Drinking Water*, p. 1-3. DHS, EPA, and WHO apparently all say that the evidence is inconclusive, but OEHHA lists chromium-6 as a carcinogen for purposes of the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65"). However, chromium-6 is not considered to pose a significant risk by ingestion, provided that its standards are being met [Title 22, California Code of Regulations, Section 12707(b)], <http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/Chromium6/Cr+6index.htm>, 3/1/01.
- 160 *State of Reviews of MCLs for 13 Contaminants*, Department of Health Services (September 19, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/phgs/reviewstatus.htm (11/8/2000), p. 3.
- 161 *Primary Drinking Water Standards Review List for 1999*, Department of Health Services, Office of Public Affairs No. 11-99 (March 15, 1999), www.dhs.ca.gov/opa/prssrels/1999/11-99.htm (11/8/2000), p. 2; *State of Reviews of MCLs for 13 Contaminants*, Department of Health Services (September 19, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/phgs/reviewstatus.htm (11/8/2000), p. 3. 1999. Full risk assessment. 7.2% of 2.5 µg/L is 0.18 µg/L.
- 162 *Primary Drinking Water Standards Review List for 1999*, Department of Health Services, Office of Public Affairs No. 11-99 (March 15, 1999), www.dhs.ca.gov/opa/prssrels/1999/11-99.htm (11/8/2000), p. 1.
- 163 For example, State Senator Tom Hayden called for fast-tracking the recommendation in a letter to Department of Health Services Director Bonta. *Hayden Urges Faster Action on Health Threat*, *Los Angeles Times*, Valley Edition (8/22/2000), p. B1. The Los Angeles Board of Supervisors also called for tests of water in Los Angeles county facilities. *'Excessive' Chromium 6 Levels Found in Area Tests*, *Los Angeles Times*, 9/22/00, p. B1.
- 164 Senate Bill 2127; *Water Tests Find High Chromium 6 Levels*, *Los Angeles Times*, Valley News, 10/5/00, p. B2.
- 165 *Water Tests Find High Chromium 6 Levels*, *Los Angeles Times Valley News*, 10/5/00;
- "Excessive" Chromium 6 Levels Found in Area Tests*, *Los Angeles Times*, 9/22/00.
- 166 This is consistent with other studies in other areas of the State. In tests conducted over the last few years, the Department of Health Services has consistently found chromium 6 levels to make up large proportions of total chromium, often between 50 and 100 percent. *Chromium-6 in Drinking Water*, California Department of Health Services (Feb. 5, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/chromium6/cr+6index.htm, 2/5/01.
- 167 *High Levels of Chromium 6 Discovered in Private Wells*, *Los Angeles Times*, 2/15/01.
- 168 *Schiff Pushes for Chromium 6 Study*, *Los Angeles Times*, 1/26/01.
- 169 The Department of Health Services has tested a different set of wells in a different area of the State every year for the past few years, but it has never tested a significant number of wells. In 1997 and 1998, it tested ten wells in central California. In 1998, it tested three wells in Southern California, and in 2000, it sampled eleven wells in northern California. *Chromium-6 in Drinking Water*, California Department of Health Services (Feb. 5, 2001), www.dhs.ca.gov/ps/ddwem/chemicals/chromium6/cr+6index.htm, 2/5/01.
- 170 *Supervisors Order Chromium 6 Cleanup*, *Los Angeles Times*, 11/15/00.
- 171 Gary Yamamoto, chief of technical programs for the Department of Health Services, as quoted in *Calls for Reducing Chromium Levels in Water Go Unheeded*, *Los Angeles Times*, 8/20/00.
- 172 Because many of the sources of hexavalent chromium are believed to be older sources, this is an example of a contaminant believed by some to be a "legacy pollutant"—see page 65 and Chapter 4, note 1.
- 173 *Lockheed Linked to Chromium 6 Pollution*, *Los Angeles Times*, 1/21/01.
- 174 *Fear of Toxin in Tap Water Rocks California Valley*, *Washington Post*, 12/8/00.
- 175 *Uncontrolled LUSTs*, Environmental Working Group (July 2000), p. 4. In addition to producing the biannual 305(b) Report, the State Water Board (and the Regional Water Boards) also monitor leaking tank systems. The information in this section comes, either directly or indirectly, from those programs.
- 176 Under California law, every tank must be either permitted or removed from the ground. "Active" tanks are those that are permitted. Phone conversation with Kevin Graves, State Water Board, 1/8/01.
- 177 *Underground Storage Tank Statistics*, California State Water Resources Control Board (Jan. 16, 2001), http://www.swrcb.ca.gov/cwphome/ust/docs/tank_stats.htm, 2/6/01; "State law and regulations require that all underground storage tanks (UST) installed before 1984 be removed, replaced or upgraded by December 22, 1998 to reduce the risk of releases of hazardous substances into the environment." Cal. Health & Safety Code §§ 25291-93.2.
- 178 "Naval Training Center: Fact Sheet," San Diego, (April 1995), <http://www.efds.navfac.navy.mil/DEP/env/PAGES/Ntcfs3.pdf>, 2/7/01.
- 179 <http://www.cleanfuels.net/USTMTBE6.htm>, 2/4/01.
- 180 *Uncontrolled LUSTs*, Environmental Working Group, (July 2000), p. 8.
- 181 *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 10.
- 182 *Los Angeles Regional Board Basin Plan* (1994), p. 4-57 (4,500 "sites" out of 18,000 "tanks", or 25%).
- 183 "Naval Training Center: Fact Sheet," San Diego, April 1995, <http://www.efds.navfac.navy.mil/DEP/env/PAGES/Ntcfs3.pdf>, 2/7/01.
- 184 *Health & Environmental Assessment of MTBE*; Vol. IV, Chapter 1 (see note 54), p. 6, <http://tsrtp.ucdavis.edu/mtberpt>, 11/12/00. As of June 2000, according to the State Board's Leaking Underground Storage Tank Information system, the total number of UST cases, both open and closed, numbered 36,827. <http://www.swrcb.ca.gov/cwphome/lustis/LUSTQ400.PDF>, 3/1/01.
- 185 *Uncontrolled LUSTs*, Environmental Working Group, (July 2000), p. 1.
- 186 An "open" site is one for which a case file was opened and data were entered into the LUFT database, and for which that file was not subsequently closed as a result of enforcement activity or as a result of the agency having declared the site clean. Open sites may be sites of ongoing pollution. *Uncontrolled LUSTs*, Environmental Working Group, (July 2000), p. 3. Voicemail message from Bill Walker, Environmental Working Group, February 8, 2001;
- 187 The federal system refers to all leaking underground storage tanks, and uses the acronym "LUST" to refer to them. California's system tracks leaking underground fuel tanks (or "LUFTs") in one program, and tracks leaks of other types of hazardous materials under its Spills, Leaks, Investigation and Cleanup (SLIC) program.
- 188 *Health & Environmental Assessment of MTBE*; Vol. IV, Chapter 1 (see note 54), p. 62, <http://tsrtp.ucdavis.edu/mtberpt>, 11/1/00.
- 189 *Uncontrolled LUSTs*, Environmental Working Group, (July 2000), p. 16, Table 4a.
- 190 See note 204.
- 191 *Uncontrolled LUSTs*, Z. Ross and B. Walker, Environmental Working Group (July, 2000), (July 2000), p. 19 (Table 7).
- 192 *Id.*, p. 16 (Table 4a)
- 193 *Id.*, p. 17 (Table 5).
- 194 Phone conversation with various Regional Water Board representatives, circa 1/25/01.
- 195 *Trouble on Tap*, NRDC (Oct. 1995), p. 22.
- 196 None of the Regional Water Board staff with whom NRDC communicated (see, e.g., Chapter 4, note 4) indicated that they tested for radon.
- 197 PicoCuries per liter is a standard measure of radioactivity, one picoCurie being equivalent to one one-trillionth of a curie, defined as a quantity of a radioactive nuclide in which 3.7 x 10¹⁰ disintegrations occur per second. *Trouble on Tap*, NRDC (Oct. 1995), p. 22.
- 198 *Id.*, pp. 22-23.
- 199 Title I—*Amendments To Safe Drinking Water Act*, §109, page 110, STAT. 1629.
- 200 *Trouble on Tap*, NRDC (Oct. 1995), Table 1B.

- 201 *Agricultural Solutions Improving Water Quality in California Through Water Conservation and Pesticide Reduction*, R. Cohen and J. Curtis (NRDC, Mar. 1998), p. 3.
- 202 *Ground Water Atlas*, Coastal Basins, p. 2.
- 203 *Water & The Shaping of California*, p. 104.
- 204 State of California, Department of Water Resources. (1958). *Sea-Water Intrusion in California*, pp. 9, 73.
- 205 Again, the term "pesticide" is used in this report to include insecticides, rodenticides, herbicides, fungicides, and nematocides.
- 206 Irrigation runoff affects both surface and ground water. A Briefing on California Water Issues, Edited by Rita Schmidt Sudman, Executive Director, Water Education, (Nov. 2000) <http://www.water-ed.org/california.asp#waterissues>, 3/6/01.
- 207 *America's Animal Factories: How States Fail to Prevent Pollution from Livestock Waste*, Robbin Marks and Rebecca Knuffke (NRDC, Dec. 1998), Chapter 1.
- 208 *Effect of Agriculture on Ground Water, Eastern San Joaquin Valley*, USGS Circular 1159 (April 1998), <http://water.usgs.gov/pubs/circ1159/sec6.html>, 3/19/01.
- 209 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994) p. 27.
- 210 California GW management, p. 30.
- 211 <http://www.ciwm.ca.gov/2000Plus/History.htm>.
- 212 *Solid Waste Disposal Facility Criteria, Proposed Rule*, 53 Fed. Reg. 33314 (Aug. 30, 1988).
- 213 California GW management, p. 30.
- 214 Lynton Baker, Renee Capouya, Carole Cenci, Renaldo Crooks, and Roland Hwang, THE LANDFILL TESTING PROGRAM: DATA ANALYSIS AND EVALUATION GUIDELINES (Sacramento, Calif.: California Air Resources Board.
- 215 *Inventory of Solid Waste Facilities Violating State Minimum Standards*, CIWMB, <http://www.ciwm.ca.gov/LEACentral/inventory/default.htm>; Cal. Pub. Res. Code § 44104.
- 216 Joe E. Heimlich, Ohio State University Community Development Factsheet 111: Landfill. <http://www.ag.ohio-state.edu/~ohioline/cd-fact/0111.html>.
- 217 *Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches*, Lee, G.F. and Jones-Lee, A., Report G. Fred Lee & Associates, Consulting firm specializing in water and waste management, El Macero, CA, (Mar. 1998), http://home.pacbell.net/gfredlee/alternative_lf.html, 2/9/01.
- 218 <http://www.chetboddy.com/articles/septic.htm>, 1/31/01.
- 219 Chet Boddy Real Estate Appraisal, Sales and Consulting, <http://www.chetboddy.com/articles/septic.htm>, 1/31/01.
- 220 *Ground Water Quality and its Contamination from Non-Point Sources in California*, UC Davis Centers for Water and Wildland Resources (June 1994), p. 27. Pathogens include viruses, bacteria, and parasites that cause disease in humans.
- 221 <http://www.co.santa-cruz.ca.us/eh/sewage/ehownergd.htm>, 1/31/01.
- 222 *Central Coast Basin Plan*, p. IV-19.
- 223 North Coast Regional Board Basin Plan, p. 4-11.00.
- 224 *Water Officials Link Malibu Septic Tanks to Beach Pollution*, Los Angeles Times (11/13/00), Section B.
- 225 Nonpoint Source News-Notes Issue #46. URBAN RUNOFF NOTES: Industrial Waste in Septic Systems Poses Hidden Nonpoint Source Threat. EDITOR'S NOTE: This article is adapted from the Groundwater Bulletin, volume 5, number 3, (Fall 1995), <http://www.epa.gov/OWOW/info/NewsNotes/issue46/nne46.htm>.
- 226 *Groundwater Protection: Emerging Issues and Policy Challenges*, Judy Campbell Bird, Environmental and Energy Study Institute (Mar. 1985), p. 8.
- 227 *Ground Water Report to Congress*, p. 9.
- 228 *Id.*
- 229 *Groundwater Protection: Emerging Issues and Policy Challenges*, Judy Campbell Bird, Environmental and Energy Study Institute (Mar. 1985), p. 8.
- 230 N-nitrosodimethylamine (NDMA) is used primarily in research, but also in "the production of 1,1-dimethylhydrazine for liquid rocket fuel, and a variety of other industrial uses: a nematocide, a plasticizer for rubber, in polymers and copolymers, a component of batteries, a solvent, an antioxidant, and a lubricant additive." They first list it as being present at aerospace industry facilities, but then say it was reported in "a variety of foods, beverages, and drugs, and in tobacco smoke; it has been detected as an air pollutant, and in treated industrial wastewater, treated sewage in proximity to a 1,1-dimethylhydrazine manufacturing facility, deionized water, high nitrate well water, and chlorinated drinking water (NTP, 2000)." <http://www.dhs.cahwnet.gov/ps/ddwem/chemicals/NDMA/NDMAindex.htm>, 3/5/01.
- 231 *The Perchlorate Contamination Challenge: EPA's Part in a Pro-Active Partnership*, by William H. Farland, Ph.D., Director, National Center for Environmental Assessment U.S. EPA, May 1, 1998, <http://www.epa.gov/safewater/ccl/perchlor/slide/sld002.htm>, 2/12/01.
- 232 *California's Experience with Perchlorate in Drinking Water*, Department of Health Services, <http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perhindex.htm>, 2/12/01.
- 233 *MCLs, Action Levels, and Unregulated Chemicals Requiring Monitoring*, California Department of Health Services, www.dhs.ca.gov/ps/ddwem/chemicals/MCL/mclindex.htm (Oct. 2, 2000), 11/8/01; *California's Experience with Perchlorate in Drinking Water*, Department of Health Services, <http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perhindex.htm>, 1/12/01.
- 234 *California's Experience with Perchlorate in Drinking Water*, Department of Health Services, <http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perhindex.htm>, 1/12/01.
- 235 *Id.*
- 236 Rialto, for example, is home to Dexter Aerospace Materials Division, Aerojet, Applied Aerospace Structures Corp., and Sandia National Laboratories.
- 237 Perchlorate is an inorganic chemical used in the production of, and as a component of, solid rocket propellant, as well as in other industrial applications. The public health concern regarding perchlorate derives from its ability to interfere with the thyroid gland's uptake of iodine to produce thyroid hormones. Thyroid hormones are required for normal body metabolism, as well as for normal prenatal and postnatal development and growth. *California's Experience with Perchlorate in Drinking Water*, DHS (October 6, 2000), <http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perhindex.htm>, 11/5/00; *The Subcommittee on Water Resources & Environment; Markup*; H.R. 910, the "San Gabriel Basin Water Quality Initiative." <http://www.house.gov/transportation/water/03-08-00/03-08-00markup.html>.
- 238 *The Subcommittee on Water Resources & Environment; Markup*; H.R. 910, the "San Gabriel Basin Water Quality Initiative." <http://www.house.gov/transportation/water/03-08-00/03-08-00markup.html>.
- 239 <http://virtual.yosemite.cc.ca.us/ghayes/goldrush.htmk>, 2/3/01.
- 240 "Overview: Environmental Mercury in California." By Walter C. Swain, (May 2000). Water-Resources Investigations Report 96-4257. <http://www.water.usgs.gov/mercury/>.
- 241 A fatal toxin, mercury impairs human kidneys, brains and nervous systems. It also acts as a carcinogen. In the 1870s and 1880s, J.B. Randol, general manager of San Jose's New Almaden mine reported Chinese mercury miners dying "shaking toothless wrecks." <http://www.sfbg.com/News/32/15/Features/gold.html>, 2/4/01. Much of this mercury still remains throughout California's water bodies. An estimated 10 to 30 percent of all mercury used in mining has escaped from the sluice through leakage into underlying soils and bedrock.
- 242 "Insights into California mercury production and mercury availability for the gold mining industry from the historical record," Churchill, R., (1999). Geological Society of America

Abstracts with Programs, v. 31, no. 6, p. 45. Cited in *Mercury Contamination from Historic Gold Mining in California*, <http://water.wr.usgs.gov/mercury/fs06100.html>.

243 <http://www.sfbg.com/News/32/15/Features/gold.html>, 2/4/01.

244 "World's Most Acidic Waters are Found Near Redding, California." By Pat Jorgenson, (March 17, 2000), <http://ca.water.usgs.gov/acid/>.

245 *Id.*

246 "U.S. and State of California Announce Long-Term Settlement for Iron Mountain Mine," (Oct. 19, 2000), <http://www.epa.gov/region09/features/ironmountain.html>.

247 "Hydrogeology and Geochemistry of Acid Mine Drainage in Groundwater in the Vicinity of Penn Mine and Camanche Reservoir, Calaveras County, California: Second-Year Summary, 1992-93." By Scott N. Hamlin and Charles N. Alpers.

248 http://water.wr.usgs.gov/sac_nawqa/sacbfs.html.

249 State Water Resource Control Board: "California's Rivers and Streams, Working Toward Solutions Publication" (1998-1999) <http://www.swrcb.ca.gov/general/publications/pubs/riversst.htm>.

250 "Leviathan Mine: Superfund Fact Sheet." Environmental Protection Agency, (November 1999).

251 Phone conversation between Dvora Inwood and Carl Hauge, Chief Hydrogeologist, Division of Water Resources, Department of Water Resources, 3/6/01.

252 Cal. Health & Safety Code § 115770.

253 Phone conversation between Dvora Inwood and Carl Hauge, Chief Hydrogeologist, Division of Water Resources, Department of Water Resources, 3/6/01.

Chapter 4

1 James Goodrich, former Executive Director of the San Gabriel Water Quality Authority and Vice-president and Board member of the National Groundwater Association, makes this claim with respect to most industrial point sources. He points to the size of plumes in the San Gabriel Valley as an example, the

likely sources of those plumes, and the concentrations of contamination at the sources. Phone conversation between Alex Helperin, NRDC, and James Goodrich, 3/7/01.

2 In 2000, the State Water Board entered into a collaborative venture with the U.S. Geological Survey and Lawrence Livermore National Laboratory to monitor the ambient conditions of the groundwater in California in order to determine the vulnerability of the water being received by any individual well. The program, known as the Ambient Groundwater Monitoring and Assessment (GAMA) program is designed to assess low-level VOCs and the overall groundwater age in drinking water wells. GAMA Program, California Aquifer Susceptibility (CAS) Assessment, State Water Resources Control Board (Oct. 2000).

3 The one exception to this is that a water body that comes close to exceeding the standard may be listed as "threatened."

4 Phone conversation between Dvora Inwood and Regional Board representatives: Region One, North Coast, Bruce Gwynne, 1/23/01; Region Three, Central Coast, Karen Worcester, 1/22/01; Region Five, Central Valley, Gene Davis, davisg@4b5s.swrcb.ca.gov, email 1/30/01; Region Six, Lahontan Region, Judith Unsicker, unsij@rb6s.swrcb.ca.gov, email 1/26/01; Region Seven, Colorado River Valley, Danny McClure, 1/23/01; Region Nine, San Diego, Linda Parady, 1/31/01.

5 Electronic correspondence from Gene Davis, TMDL Unit Information Management, Central Valley Regional Water Quality Control Board, 1/30/01. Central Coast Region representatives also indicated that their information was gathered from site-specific problems and expert, anecdotal evidence. Phone conversation between Dvora Inwood and Karen Worcester, Central Coast Regional Water Quality Control Board, 1/22/01.

6 Phone conversation between Dvora Inwood and Colorado River Basin, Region 7, Danny McClure, 1/23/01.

7 Phone conversation between Dvora Inwood and Linda Parady, San Diego Region Nine, 1/31/01.

8 Phone conversation between Dvora Inwood and Regional Board representatives: Region One, North Coast, Bruce Gwynne, 1/23/01; Region Three, Central Coast, Karen Worcester, 1/22/01; Region Five, Central Valley, Gene Davis, davisg@4b5s.swrcb.ca.gov, email 1/30/01; Region Six, Lahontan Region, Judith Unsicker, unsij@rb6s.swrcb.ca.gov, email 1/26/01; Region 7, Colorado River Valley, Danny McClure; Region Nine, San Diego, Linda Parady, 1/31/01. Phone conversations between Alex Helperin and Terry Fleming, USEPA Region IX 305(b) coordinator, 12/18/00 and 12/28/00.

9 1998 305(b) Report on Water Quality, State Water Resources Control Board, (May 1999), p. 2. None of the 305(b) Report updates the total areal extent of groundwater in the State. A separate analysis of the areal extent of groundwater in California, based on the Department of Water Resources' groundwater basin map, indicated a total of about 63,000 square miles, excluding volcanic areas. This is obviously in conflict with the State Water Board figures.

10 It also represents a steady decrease in the amount assessed each time the report comes out. The 1992 305(b) Report reported assessment of 94,500 square miles of groundwater; the 1994 report, 90,433 square miles; and the 1996 report, 65,354. See Table 3 on page 14.

11 $62,652/82,000 = 76.4\%$. In addition, it appears that there may be even more threatened and impaired waters than are reported in Table 2, as the San Diego region may have failed to list some of the waters in which salinity was a cause of threat or impairment as impaired or threatened waters. Correspondence with Nancy Richard, Environmental Specialist and 305(b) Coordinator, State Water Board (Jan. 31, 2001).

12 The California Governor's annual budget lists over 20 different funding sources for the State Water Resources Control Board (2000-2001 budget, ch. 52, http://www.dof.ca.gov/HTML/BUD_DOCS/Bud_Link.htm). In addition, the 2000 Water Bond offers \$763 million to safe drinking water projects, water treatment and recycling, et al. \$1.2 billion is

provided by the Safe Neighborhood Parks, Clean Water, Clean Air and Coastal Protection Bond Act of 2000.

13 See page 35.

14 See Figure 14.

15 <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>, 12/29/00 and 2/8/01; phone conversation between Dvora Inwood and Rick Rhoda, Sanitary Engineer Associate, Division of Drinking Water and Environmental Management, California Department of Health Services, January, 2001, and DHS literature on web site.

16 Phone conversation between Dvora Inwood and Regional Board representatives: Region One, North Coast, Bruce Gwynne, 1/23/01; Region Three, Central Coast, Karen Worcester, 1/22/01; Region Five, Central Valley, Gene Davis, davisg@4b5s.swrcb.ca.gov, email 1/30/01; Region Six, Lahontan Region, Judith Unsicker, unsij@rb6s.swrcb.ca.gov, email 1/26/01; Region 7, Colorado River Valley, Danny McClure; Region Nine, San Diego, Linda Parady, 1/31/01.

17 Phone conversation between Dvora Inwood and Gene Davis, TMDL Unit Information Management, Central Valley Regional Water Quality Control Board, 1/31/01.

18 Phone conversation between Dvora Inwood and Judith Unsicker, Lahontan Regional Board (attributing trace metals and arsenic to geothermal springs and volcanic actions around the Mammoth area), 1/19/01.

19 Electronic correspondence from Gene Davis, TMDL Unit Information Management, Central Valley Regional Water Quality Control Board, 1/30/01.

20 Phone conversation with Bruce Gwynne, North Coast, Region One, 707-576-2661, 1/23/01.

21 Phone conversation between Alex Helperin and James Goodrich, former Executive Director of the San Gabriel Water Quality Authority and Vice-President and Board member of the National Groundwater Association, 3/7/01.

22 Phone conversation between Alex Helperin and Carl Hauge, Chief Hydrogeologist, Department of Water Resources, 3/12/01.

23 Figure as of 1987. *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 21.

24 This figure is based on a search of the database for wells coded as Abandoned (AB), Destroyed (DS), or otherwise Inactive (IR, IT, or IU).

25 Although the coding does not indicate the cause for the decommissioning, officials within the Drinking Water program confirmed that contamination is a major cause of decommissioning. Phone conversation between Alex Helperin, NRDC, and David Spath, Division Chief, Division of Drinking Water and Environmental Management, California Department of Health Services, 3/9/01.

Chapter 5

1 "Preliminary Strategy Ground Water Quality Protection" p. 3.

2 Clean Water Act Spill Prevention Control and Countermeasure Plans, 40 C.F.R. Part 112; Above-ground Petroleum Storage Act, Cal. Health & Safety Code, Div. 20, Chap. 6.67, sections 25270-270.13.

3 Federal Safe Drinking Water Act, Part C, 42 U.S.C. §§ 300h *et seq.*, Underground Injection Control Program, 40 C.F.R. Parts 144-147; Surface Mining Control and Reclamation Act, 30 U.S.C. §§ 1201-3128; California Surface Mining and Reclamation Act, Cal. Pub. Res. Code §§ 2711-98 (particularly § 2770 *et seq.*); Hazardous Waste Reduction, Recycling, and Treatment Research & Demonstration Act of 1985, Cal. Health & Safety Code §§ 25244-244.11.5; Oil & Gas UIC Wells, Cal. Pub. Res. §§ 3000 *et seq.* and 3700 *et seq.*; Well Standards, Cal. Water Code §§ 13700 *et seq.*

4 Hazardous Liquid Pipeline Safety Act, see 49 U.S.C. §§ 2001 *et seq.*, and Hazardous Materials Transportation Act, former 49 U.S.C. §§ 1801 *et seq.*, 40 U.S.C. §§ 5101 *et seq.*; Hazardous Waste Control Act, Cal. Health & Safety Code §§ 25100-250 (Div. 20, Chap. 6.5).

5 Resource Conservation and Recovery Act, 42 U.S.C. §§ 6921-39b; Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. § 136-136y; California Hazardous Waste Control Act, Cal. Health & Safety Code §§ 25100-250 (Div. 20, Chap. 6.5); Underground

Storage Tank Facility Regulation, Cal. Health & Safety Code, Div. 20, Ch. 6.7 (§§ 25280-299.7); Above-ground Petroleum Storage Act, Cal. Health & Safety Code, Div. 20, Chap. 6.67, sections 25270-270.13.

6 Clean Water Act, 33 U.S.C. §§ 1251-1387; Resource Conservation and Recovery Act, 42 U.S.C. §§ 6921-39b; Hazardous Waste Control Act, Cal. Health & Safety Code §§ 25100-250 (Div. 20, Chap. 6.5); Porter-Cologne WQ Control Act, Cal. Water Code §§ 13000-14050.

7 Resource Conservation and Recovery Act, 42 U.S.C. §§ 6921-39b; Atomic Energy Act, 41 U.S.C. §§ 2014, 2021-22, 2111-14; Safe Drinking Water Act, 42 U.S.C. §§ 300f - 300j-26; Toxic Substances Control Act, 15 U.S.C. §§ 2601-92; and Uranium Mill Tailings Radiation Control Act, 42 U.S.C. §§ 7901-42; Hazardous Waste Control Act, Cal. Health & Safety Code §§ 25100-250 (Div. 20, Chap. 6.5); Toxic Injection Well Control Act, Cal. Health & Safety Code §§ 25159.10 - 159.25; Porter-Cologne WQ Control Act, Cal. Water Code §§ 13000-14050 (Preliminary Strategy, p. 8); Toxic Pits Clean Up Act, Cal. Health & Safety Code, Div.20, Ch. 6.5, Art. 9 (§§ 25,208 *et seq.*) (PS, p. 9); Oil & Gas UIC Wells, Cal. Pub. Res. §§ 3000 *et seq.* and 3700 *et seq.*

8 Federal Insecticide, Fungicide and Rodenticide Act, 7 USC § 136-136y; Toxic Substances Control Act, 15 U.S.C. §§ 2601-92; Federal Land Policy and Management Act, 43 U.S.C., §§ 1701-1785; Pesticide Contamination Prevention Act, Cal. Food & Agr. Code §§ 13141-52.

9 National Environmental Policy Act, 42 U.S.C. §§ 4321-4370b; California Environmental Quality Act, Cal. Pub. Res. Code §§ 21000 *et seq.*

10 Coastal Zone Management Act, 16 U.S.C. §§ 1451-64; Safe Drinking Water Act Wellhead Protection Program, 40 U.S.C. 300h-7; Clean Water Act, 33 U.S.C. §§ 1251-1387; Federal Land Policy and Management Act, 43 U.S.C., §§ 1701-1785; California Coastal Act, Pub. Res. §§ 33,000-900 (particularly §§ 30231 *et seq.*); Local Planning Act, Cal. Gov't Code §§ 65000 *et seq.*

11 Sole Source Aquifer (SSA) program under Section 1424(e) of the Safe Drinking Water Act (SDWA), "The intention of the

program is to prevent federal funding of projects which might contaminate an aquifer which is the sole or principal source of drinking water for an area," <http://www.epa.gov/earth1r6/6wq/swp/ssa/effects.htm>, 3/1/01.

12 Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-9675; State Water Board Spills, Leaks, Investigations and Cleanups (SLIC) program, Portion-Dolwig Groundwater Basin Protection Act, Cal. Water Code §§ 12920 *et seq.*; Public Water Well Evaluation (AB 1803), former Cal. Health & Safety Code § 4026.2; Solid Waste Assessment Test, Cal. Water Code § 13273 *et seq.*

13 "Preliminary Strategy Ground Water Quality Protection" p. v. Again, some experts claim that some programs are adequate, and that the contamination from sources regulated by such programs is "legacy pollution." See page 65 and Chapter 4, note 1.

14 "Executive Summary," *In Harm's Way*, Greater Boston Physicians for Social Responsibility (May 2000), <http://www.preventingharm.org/execsum.html>, 2/7/01.

15 *Id.*

16 Compare 22 C.C.R., Div. 4, Chapter 15, sections 64431-64450 with EPA's list of 80,000 chemicals.

17 State Water Resources Control Board *Strategic Plan* (SWRCB, July 1997), p. 4.

18 42 U.S.C. §§ 6991-6991i.

19 42 U.S.C. § 6991b(a) and (c).

20 42 U.S.C. § 6991(1) and (2)(A).

21 42 U.S.C. § 6991(1)(C).

22 42 U.S.C. § 6991(1) (A).

23 See Hazardous Substance Underground Storage Tank Facility Regulation/Registration Law, Cal. Health & Safety Code, Div. 20, Ch. 6.7 (§§ 25280-299.7); 23 C.C.R., Division 3, Chapter 16, Articles 1-10, §§ 2610-2714.

24 <http://www.cleanfuels.net/USTMTBE6.htm>, 2/4/01.

25 *Uncontrolled LUSTs*, By Bill Walker and Zev Ross, Environmental Working Group (July 2000) p. 9.

26 42 U.S.C. § 6991c.

27 *Uncontrolled LUSTs*, By Bill Walker and Zev Ross, Environmental Working Group (July 2000), p. 3.

28 *Executive Order D-5-99*, by the Governor of the State of California, Governor Gray Davis, March 25, 1999.

29 Draft Staff Findings: *Timetable for the Phaseout of MTBE from California's Gasoline Supply*, G. Shremp, California Energy Comm'n, Docket No. 99-GEO-1 (June 1999).

30 *MTBE in California Drinking Water*, California Department of Health Services (Oct. 6, 2000), www.dhs.ca.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm, 11/1/00.

31 Phone Conversation between D. Inwood and Steve Brisby, Manager, Fuel Section, Stationery Sources, California Air Resources Board, 2/16/01.

32 *Clean ethanol may replace MTBE in fuel*, By John Howard, Associated Press, *Contra Costa Times*, 11/17/00.

33 http://www.swrcb.ca.gov/~cwphome/ust/docs/ab2886/emergency_findings.htm.

34 The URL for the GeoTracker website is: <http://geotracker.llnl.gov/>.

35 http://www.swrcb.ca.gov/~cwphome/ust/docs/ab2886/emergency_findings.htm.

36 Cal. Water Code § 13263.

37 Cal. Food & Agr Code §§ 13,140—152.

38 7 U.S.C. § 136-136y.

39 *Ground Water Report to Congress* (Ground Water Protection Council, October 1999), p. 22.

40 *Preliminary Strategy Ground Water Quality Protection* (State Board, Nov. 1987), p. 7.

41 42 U.S.C. §§ 6901-6991i.

42 40 C.F.R. §§ 239-82.

43 *Solid Waste Disposal Facility Criteria, Proposed Rule*, 53 Fed. Reg. 33314 (August 30, 1988).

44 42 U.S.C. §§ 6921-39b.

45 *Ground Water Report to Congress* (Ground Water Protection Council, Oct. 1999), p. 22.

